cm-223
Project 2.6
CZ/30

ASSESSMENT OF FISHERIES HABITAT

FINAL REPORT
for
TASKS 1, 2, 3, and 4

DECEMBER, 1989

Funds for this project were provided by the Department of Environmental Regulation, Office of Coastal Management using funds made available through the National Oceanic and Atmospheric Administration under the Coastal Zone Management Act of 1972, as amended.

ASSESSMENT OF FISHERIES HABITAT
TASKS 1, 2, 3, and 4

FINAL REPORT

for

GRANT PERIOD 4/1/89 thru 12/30/89

Kenneth D. Haddad, Gail A. McGarry, Richard E. Matheson, Jr.,
Walter J. Conely, Paul Carlson, Michael Durako,
Jamie L. Serino, and Timothy MacDonald

December, 1989

Department of Natural Resources
Division of Marine Resources
Florida Marine Research Institute

Funds for this project were provided by the Department of Environmental Regulation, Office of Coastal Management using funds made available through the National Oceanic and Atmospheric Administration under the Coastal Zone Management Act of 1972, as amended.

EXECUTIVE SUMMARY

This report contains Tasks I-IV of the Coastal Zone Management program at the Florida Marine Research Institute. Task I work products are centered around the development of the Marine Resource Geographic Information Systems (MRGIS) and the dissemination of both digital and hard copy data into the user community. A focus of this Task has been the development of a detailed GIS database for the Little Manatee River Watershed. Data layers are in various stages of completion and analyses have been conducted. Task II work products are based on the goal to link and quantify the relationship between fisheries species to estuarine habitats. A major effort, linked to Task I, to study the distribution of fishes in the Little Manatee River, relative to salinity, habitat and land-use, has been continued in this Task. Sampling has been on a two week basis and preliminary analyses are providing information on the distribution of fish relative to salinity. Task III work products complete a project relating potential environmental stresses (i.e., hypoxia, light) to physiological correlates of _Thalassia testudinum_. A stress indicator (ethanol) has been identified for hypoxia events and sulfide toxicity and recovery have been observed. An assessment of carbon (food) uptake in _Thalassia_ has also been conducted, demonstrating that this plant can use multiple carbon sources. This suggests that foodweb assessments will be difficult when using carbon isotope signatures. This work complements previous CZM work that identified environmental stress and loss of seagrass habitat as a major problem in long term resource management. These three tasks now represent a major thrust of the Florida Marine Research Institute to develop techniques and provide information to more effectively manage our marine resources.

Since sound information on habitat quantity, location, and importance to Florida's fisheries and non-game resources has never been addressed with a methodical, holistic approach, this type of information has not been available to the researcher or resource manager. Although much of what we are doing will require long term database development, the preliminary information has been and continues to be requested by agencies, planners, and researchers. We expect this program to continue to grow and the knowledge gained to be of critical importance to the future of our coastal natural resources.

Task IV is providing the vehicle to get our information and project results to the general public. The Seagrass Task Force Report is in the final editing stage and is being prepared for publication and will be an important document for those concerned with management of this resource. The most effective approach to resource management is by an informed public guiding the governmental processes. By providing factual non-technical information to the public, they can make better decisions when facing tough issues regarding our marine environment. Through brochures, presentations and other forms of media, we are accomplishing these goals and the results can only be positive for Florida's future.

Task 1: MARINE RESOURCE GEOGRAPHIC INFORMATION SYSTEM (MRGIS)

The primary objectives of this task were to continue the development of the Little Manatee River (LMR) watershed GIS data base, distribute MRGIS digital, tabular and hardcopy habitat data, improve our capability for hardcopy map production, expand MRGIS interfaces to tabular data, and field test the multi-spectral video imaging system. Also, we added data layers on an estuarine basis for Tampa Bay and Apalachicola Bay.

MRGIS Development for the Little Manatee River Watershed

The development of the LMR GIS database has progressed with major focus on completion of data layers important to water quality analyses. These data will be analyzed for correlations between various landcover, land-use, and soil components and various water quality and fisheries data currently being collected.

GIS DATABASE DEVELOPMENT

The development of a GIS database is complex, dynamic and requires data acquisition from many sources. Since the future analyses to be conducted with the GIS data layers will be quantitative, it is imperative that cartographic integrity be maintained. This constraint has inhibited the data entry but the results of maintaining this approach will have long-term benefits.

Figure 1 depicts some of the layers of data being implemented on the Marine Resource Geographic Information System (MRGIS). These layers represent data we have accessed, identified as available in map form, or can be generated from aerial photography or satellite imagery.

The base map (data layer to which all other layers are referenced) consists of an April, 1988 SPOT satellite panchromatic image geo-referenced to 7.5 minute U.S.G.S. quadrangles in a Universal Transverse Mercator (UTM) projection. The MRGIS data layers are currently in raster format although we can accept vector data or convert raster data to vector for various analyses or for data distribution.

Data Layers

Numerous problems have been encountered generating appropriate overlays. Some data sources, problems, and solutions are depicted in Table 1. It should be understood that many of these databases were not created with GIS entry in mind and do not have the cartographic integrity of a photogrammetrically developed map. Problems have been compounded by the fact that the rectified SPOT data were more spatially resolved that National Map Accuracy Standards for 1:24,000 maps, making geo-referencing difficult and creating overlay problems at common borders (eg., shorelines defined by soils vs. land use vs. flood zones). Furthermore, many data are in scales smaller than 1:24,000, compounding overlay difficulties. This does not present a problem if the limitations of the analyses are understood and not misused. For example, the future land-use data, if originally developed by the county at 1:100,000 scale, cannot be applied to individual zoning issues at a parcel level but can be used to project land-use changes over larger portions of the watershed.

Complete watershed coverage has been built for flood zones, future land use, and general land cover 1988. The estuarine portion of the watershed has land cover 1950 and land cover 1982 completed. The status and specific problems with several remaining data layers are as follows:

1. Soil: Soil data have been recompiled, by the Soil Conservation Service, and scan digitized for the LMR portion of Hillsborough County. Those data are in the MRGIS and being corrected and quality checked. The data are currently grouped by U.S.G.S. quad. Joining the quads (edge matching) to provide a continuous watershed coverage has proven difficult due to the complexity of soils polygons. Soil quads for the Manatee County portion of the watershed have been received and joined to form a continuous coverage. Based on preliminary observations, it appears that merging the soils data from Manatee County with Hillsborough County will be challenging. Problems are occurring in the edge matching process and disparate polygon labelling.

2. Elevation: The Southwest Florida Water Management District is providing this particular data layer. The data have been generated and we are currently developing the methods and formats for data transfer.

3. Drainage: This data layer is the most tedious effort for compilation. NHAP photos (1:50,000 scale) have been enlarged to 1:24,000 scale and detailed drainage line work is being interpreted. This type of interpretation has not been done for many areas in the U.S., particularly at the resolution being attempted for this program. For example, individual drainage ditches within agricultural fields are being identified, along with their connectivity to the tributaries of the watershed. This will allow better analysis of sources of waterborne constituents and will allow network analyses.

4. Land cover/Land use: A land cover layer has been developed for the entire watershed. This was developed by the Florida Game and Freshwater Fish Commission in cooperation with the FMRI. These data are for 1987 (from Landsat Thematic Mapper) and provide a first look at land cover from a habitat and runoff potential. A 1988 SPOT image is being used to complete adetailed land use coverage. The land use data are being compiledat a 0.1 hectare resolution.

5. Watershed and subbasins: This data layer has been digitized from maps provided from SWFWMD (Figure 2). We have judged the boundaries to be inaccurate in many areas because the basins were originally delineated in the 1970s. Substantial changes have occurred in the drainage characteristics of the watershed which need to be readdressed by the U.S.G.S.

Tabular attribute data

Tabular data, such as soils definitions, bald eagle nesting locations, LMR station locations and all of the associated water quality or fish distribution data, permitted effluent discharges, and other digital data that represent a singular geographic location are also required for analyses. The biggest problem in working with these data are positional accuracies and data exchange formats.

Quality Control and Assessment

Data quality control and assessment are extremely important in the generation of the GIS data layers and their tabular attributes. The two components of concern are cartographic integrity and data accuracy (i.e., is it where it should be and is it being called the right thing?). When accessing data bases outside the control of FMRI, these issues are often difficult to assess prior to data entry. Where we have control, such as in the soils digitization, we have taken extreme measures to insure cartographic integrity but we can only accept the Soil Conservation Services ability to properly identify soils. In most cases accuracy assessment of the information has not been completed by the parent organization. For data being developed at FMRI, such as land use, statistical analyses of classification errors are being conducted.

Data analyses

Numerous test analyses have been conducted on portions of the watershed with many of the data layers. Only the results of an analyses specific to water quality data will be presented. The specific analyses addressed the issue of what land covers comprise the drainage area (subwatersheds) of each of seven water quality stations. This type of information, in conjunction with other data layer information, can be used to assess the contribution of runoff to water quality findings.

Table 2 summarizes the general coverage, in hectares, for each of the 7 water quality stations depicted in Figure 2. It should be noted that subwatersheds are defined by station locations while subbasins are defined by U.S.G.S. criteria. These data do not reflect subbasin analyses.

The entire watershed comprises 57,364 hectares (573.64 sq. kilometers). Upland plant communities comprise 13% of the watershed and consist of pinelands to hardwood forests. Wetland plant communities constitute 9% of the watershed ranging from saltmarsh to hardwood swamp. Water bodies comprise 3% of the watershed, not including the river and its tributaries.

Agriculture/pasture/barren constitute 75% of the watershed. This category is very general and includes urban areas. Urban areas represent a small portion of this percentage and will be well defined in the detailed land use data layer. In Table 2 this category is representative for the subwatersheds except at ST7 which is the urbanized Sun City Center area.

Within each of the subwatersheds, the dominant land cover is agriculture/pasture/barren with a high of 90% at ST2 and a low of 63% at ST4. Most of the areas are in agriculture with a small percentage of pasture. At ST1 the coverage is dominated by pasture rather that agriculture and at ST7 the coverage is dominated by barren (or urban in this case).

Although these data have significance in their current form, the full power of the data will be realized as the investigators begin to associate their finding with the information in each data layer or by association of multiple data layers.

Many analyses which have been conducted with the various data layers have not been presented in this final report due to the pictorial nature of the results. Multiple layered analyses have been successfully tested and preliminary results are being reviewed by local governmental planning agencies through pictorial presentations of the data development process and analyses results. A manuscript titled Basisn-Wide Management summarizes some of the analysis results (Task 1, Attachment A). In addition, a manuscript is currently in preparation which describes the difficulties and solutions for digitizing soils data in a cartograghically accurate base and summarizes analyses using soils data. The focus of the soils analyses are on results applicable to enhancing watershed management.

Future Work

The development of the LMR MRGIS data base is one of the most detailed and extensive for any area in the U.S.. This is necessary due to the resolution of the water quality and biological data being collected for the watershed. This also means that the data base development must be of high accuracy if the process is to be quantifiable. The unification of all of the watershed data will result in the ability to quantitatively analyze the relationship between upland development, wetland functions, water quality, environment, and ultimately the effects of changes of these parameters on the local fishery production. This has never been accomplished at the resolution being applied in this program. The future work includes the addition of data layers not yet available at the needed resolution and replacement of data layers which are being used until better resolution data can be digitized. Substantial effort must be placed on the integration and analyses of the disparate forms of data for the watershed. In addition, the process and results need to be systematically presented to state and local government in order to facilitate a better understanding of the implications of their decisions on the LMR watershed. This can only be accomplished by presentation of accurate and usable information. The final accomplishment will be the transfer of the technology to management agencies and implementation of applicable portions of the LMR GIS data development and analyses approach to other regions of the State.

MRGIS Data Distribution

Numerous requests for data and data analyses continue as part of the CZM MRGIS operations. Table 3 list some of the requesters for maps, data summaries, and presentations between April and December 1990. It can take hours or weeks to fulfill these requests depending on the area and types of data to be created or extracted from the MRGIS. The requests can range, for example, from the simple reproduction of an existing map of the Big Bend area to high level mapping of the Lake Jackson Aquatic Preserve and the entire watershed. Table 3 does not reflect multiple requests from the same entity nor the many "over the phone" requests which are completed with a few minutes of work.Collectively, the data and other related requests consume a substantial portion of MRGIS operations. We continue to believe that this effort contributes substantially to improved natural resource decisions at federal, state, regional, and local levels. To improve data distribution capabilities an 8 pen, 38 inch bed, Calcomp plotter and a 300 dpi, color, wax-thermal printer have been added to the MRGIS. The plotter allows vector data to be printed at large scale from ARC/INFO. The wax-thermal printer allows color printing of the raster data at high resolution and with greater clarity than the inkjet printer. The color prints in this report are from this hardcopy device.

MRGIS APPLICATIONS

The techniques developed with the MRGIS for wetlands mapping and trend analyses are currently under evaluation by the NOAA Coastwatch Program and the federal multi-agency Habitat Loss and Modification Working Group for implementation of a nation-wide coastal wetland monitoring effort and for evaluation of the "no net loss" policies being planned by the various federal agencies. The following section is a draft manuscript to be included in a USFWS publication, which summarizes the techniques and concepts applied to the MRGIS mapping and trend analysis efforts.

MARINE WETLAND MAPPING AND MONITORING IN FLORIDA

INTRODUCTION

The State of Florida has one of the most extensive coastlines in the United States and climatically ranges from tropical and sub-tropical to temperate. This has resulted in a very complex and diverse assemblage of species and habitat which are often unique and fragile. Florida's population growth is one of the highest in the nation with over 80% of state inhabitants living within 16 km of the coastline. The resultant impacts on our marine and estuarine resources, although at times obvious, have been poorly understood, rarely quantified, and assumed to be far reaching.

ECOSYSTEM ANALYSES AND MANAGEMENT

With such a diverse richness of Florida's marine resources and a resultant diverse group of users, management of the resources is not an easy task. This is compounded by the rapid growth occurring in the State and its currently unquantifiable impact on our marine resources.

A primary goal of the Florida Department of Natural Resources, Marine Research Institute is to conduct research and synthesize that research into information which can be used to make sound resource management decisions. Most marine resource management strategies and actions in Florida have been oriented to single species. As technical data on the status and trends of our coastal and marine resources have become available, it has become evident that this targeted approach to management is inadequate over the long-term. Habitat has been lost, species abundance has declined, polluted waters have reduced shellfish harvest areas, and fisheries have been closed.

This realization has been stimulating the evolution of an ecosystem approach to resource management. This approach is based on the fact that without an understanding of species interactions, communities, community interactions, and cumulative environmental impacts (natural and man-induced), our management actions will often be reactive rather than preventive or corrective.

HABITAT MAPPING AND TREND ANALYSES

A first step in building a digital ecosystem database is the determination of the extent and location of critical habitat. In 1983 FMRI, through the NOAA Office of Ocean and Coastal Resource Management and Department of Environmental Regulation, initiated a program to map and monitor coastal wetlands and submerged habitat including saltmarsh, mangroves, submerged aquatics, oyster reefs, and unconsolidated bottom. With such an expansive coastline in Florida, unconventional methods for the mapping effort were analyzed.

Initially, mapping techniques were evaluated to determine cost, accuracy, and production time comparisons between digital image processing of Landsat Thematic Mapper (TM) data and cartographic aerial photography methods. A 69% cost saving and 83% production time reduction was realized with TM data (Haddad and Hoffman, 1985a). It was also determined that aerial photography was often needed for photointerpretation and digitization into the resource map when submerged habitats were being mapped (Haddad and Hoffman, 1985b). Accuracies of classification for both aerial photographs and TM data were >90% for marine wetlands. Based on these results FMRI began a systematic mapping of Florida's estuarine and marine wetlands, excluding the Everglades National Park and Biscayne Bay. That effort began in 1984 and was completed with updates in 1986 and required approximately 2 man years of effort (1 man year = 2080 hrs).

TREND ANALYSES

Habitat trend analyses have also been completed for selected areas of the State from the 1940's to the present. A major conclusion from the trend analyses have been that submerged aquatics have often undergone the greatest loss and this loss is no longer due to mechanical impacts but rather changes in water quality. This is supported by the fact that losses often occur in deeper waters within the estuaries, suggesting insufficient light penetration as a causative factor. Loss of marsh and mangrove has substantially decreased in Florida and where sufficient protective measures have been established, increases in aerial extent have been observed.

MAPPING TECHNIQUES

A decision on a base map was required early in the program. The base map is the digital map to which all data are referenced. As is common for many areas, none were not available in digital form on a statewide basis and the cost or digitization was prohibitive. It was determined that the only reasonable approach was to make the TM data the base map and any additional map layers (i.e., seagrass, oysters) would be digitally rectified to that base.

GEOGRAPHIC REFERENCING

TM data consist of 6 spectral layers of information for each 1/4 acre (30m x 30m) on the ground, and a thermal band with 4 acre resolution. Each spectral band is rectified to 7.5 minute USGS Quadrangles in a UTM projection using a bilinear interpolation technique. Welch et al, 1985 have determined that this type of process can achieve accuracy standards for 1:50,000 scale maps and approach standards for 1:24,000 scale maps. Rectification of the individual spectral bands, rather than the finished product, is standard because of our need to continually return to the raw data for additional analyses.

IMAGE ANALYSES

We have not developed a rigid protocol for statistical analysis of the satellite imagery data, but workable techniques have been standardized. Numerous types of statistics have been tested for their ability to classify marine and estuarine wetlands and for computer processing times. Standard classifiers such as the maximum likelihood, which can use either supervised or unsupervised approaches to generate statistical clusters, have been found to be processing intensive and cumbersome in a production operation. This observation is based on our specific needs, relative to coastal wetlands, and does not consider the use of this approach for general mapping needs. With this type of algorithm, and most algorithms in use, the higher the spatial resolution the more difficult it is to resolve confusion within and among classes. At some point human intervention with a photointerpretive-like process is necessary.

Our approach has been to use a very rapid parallel-piped type of classifier to initially process the date into 256 classes. The classifier is run on the green, red, and near-infrared, and the red, near-infrared, and mid-infrared TM spectral bands, respectively, to generate two statistical images. The first image is pictorially similar to a color-infrared photograph and can be image interpreted by identifying those clusters which represent the wetland categories of interest. It is often advantageous to use the second image because of its accentuation on the infrared bands. In particular, we have found that the mid-infrared band enhances our ability to differentiate wetlands. In many cases, we use both images to selectively differentiate categories of interest with the results being a third image comprised of the best clusters from each image.

Although this approach is rapid and effective it still does not meet accuracy standards expected for wetlands mapping when compared to interpretation of photographs at similar spatial resolutions. The associative and subjective analyses performed by a photointerpreter are not yet reproducible statistically. On the other hand, use of the TM mid-infrared band can have advantages in certain analyses where identification of different levels of moisture content enhance the ability to differentiate wetland types beyond those observable in an infrared photograph.

Once the images are clustered as best can be statistically accomplished, NHAP aerial photographs, existing National Wetlands Inventory (NWI) maps, ground truthing, and a myriad of other data sources are used to identify or confirm clusters which are not pure to a given wetland type. For example, some of the clusters representing mangroves may be confused with a wet orange grove or a freshwater wetland resulting in a 70% identification accuracy. The remote sensing literature has many examples of this type of confusion and reports the statistical inaccuracies of this type of analysis. This reflects an academic approach to image analyses and not a production approach. We routinely "fix" the confused clusters by using simple digital manipulations based on the interpreter's assessment of the data. Orange groves and freshwater wetlands are reclassed into appropriate categories often increasing identification accuracies for mangroves >95%.

This flexible and rapid approach to wetlands mapping results in a high accuracy product but only for wetlands. We routinely produce a final map product which merges the wetland types with the original color infrared-like image. By providing this pictorial image for the background data, the user is able to orient to the image and eliminate the need for a summary presentation of the data not classified as wetlands.

SEAGRASSES

Seagrass mapping presents special problems for satellite image analyses. Landsat only collects an image over a given area once every 16 days. This means that conditions conducive to mapping must all coincide on that given day. If the water is clear and clouds do not obscure the area, there is good potential for using imagery for seagrass mapping. We have not found any statistical analyses which adequately define seagrasses, although we have had success in limited cases. Variations in water clarity, water depth, and sediment type preclude the use of standard spectral analyses. The image must be manually "photointerpreted" in either the blue, green, or red spectral bands. Because of these obstacles we commonly use aerial photography, either existing or contractually flown, to map seagrasses. The photographs are photointerpreted, rectified to the Landsat base map, and the seagrass coverage is conventionally digitized as wetland types into the database.

HABITAT TREND ANALYSES TECHNIQUES

Trend analyses for coastal wetlands can be conducted with numerous techniques. The creation of the data for actual analyses must be with caution because, in most cases, it is difficult to separate errors in classification from actual habitat changes. Trend analyses cannot be conducted on data that use different classification systems that have not been normalized. In fact, it is very difficult to compare data that have been interpreted by different investigators using the same classification system if tedious interpretive calibrations are not conducted. If done properly, habitat trend analyses can provide valuable insights on impacts of habitat management regulations and changes in resources which utilize those habitats.

HISTORICAL DATA

Historical analyses have been accomplished for a number of areas in Florida by photointerpreting archived photographs from the 1930s to 1970s. We rectify the interpreted data to the Landsat base map and table digitize them into a separate data layer. When using aerial photography the interpretations often must be transferred to a USGS quadrangle to geo-correct the data for spatial inconsistencies prior to digitization. We can often bypass this step by using a three point triangulation method when digitizing off the photographs. When positional deviations are observed new points are picked and the digitization process if continued. If the interpretation of the historical photographs is compatible to the TM analyses then trend analyses can be conducted. We have not attempted to compare historical Landsat MSS data to the recent TM data because of the uncertainties introduced by spectral and spatial resolution differences.

CONTEMPORARY DATA

When building a database for trend analyses it is important to create an accurate habitat data layer to which historical and future data will be compared. It is our conclusion that contemporary data should be that layer. The contemporary data can be ground truthed and corrected for errors in classification which cannot be done for historical photographs. This also gives the investigator a "feel" for the area and increases the potential for accurate interpretation of the historical photos. By expending initial efforts in the creation of the contemporary data, a considerable reduction in effort is realized when developing the historical database and conducting future map updates.

DATABASE UPDATES

One approach to updating the habitat database is to remap a given area for comparison with the original maps. That process is time consuming. Since TM data are digital we have developed a technique which takes advantage of that attribute. When working with a focused database, such as coastal wetlands, we process the new TM data into 256 classes as previously described. This produces an image, rectified to the base map, which can be manipulated to update the original map. The original data are used to mask a given habitat which is then compared in a very rudimentary fashion to the new TM image. For example, when updating mangroves, we would use the original coverage of mangroves to locate those areas in the new TM image which should contain mangroves. Mangroves, in the new image, can be expected to fall within a specific range of statistical clusters and those clusters which fall outside that range are identified as potential areas of change. These areas can then be visually assessed to the changes. In theory, an inverse process can be used to identify areas of mangrove growth but we have not tested this approach due to insignificant amounts of growth in wetlands since our initial mapping effort utilizing TM data.

PROBLEMS WITH DISPARATE DATA

Figures 3-5 depict the results of the updating process except that we have used mangroves digitized from a 1982 NWI aerial photographic mapping effort as the mask to a 1987 TM image in order to show both the process and, if using disparate data sources, the problems. The observed areas of change represent differences in final product resolution, habitat classifications, and real changes in habitat. Figure 3 is a general map of a coastal area of Tampa Bay, Florida. The data have been consolidated to 3 classes and are a digital representation of the 1982 NWI map. Figure 4 represents the statistically clustered 1987 TM data for the area of mangroves delineated in the 1982 data. Figure 5 shows those areas which were labelled as mangrove in 1982 but were not classified as mangrove in 1987. Quantitatively the area was reduced from 2,952 ha of mangrove to 2,564 ha, a 13% loss. However, when investigating the changes it becomes obvious that a large portion of that change is not real and represents differences in interpretation techniques and classification systems. Many of the smaller areas of change are actually uplands within the mangrove complex. These types of features are averaged by the photointerpreter to become mangroves even though the photography was 1:24,000 scale. In the photointerpretation and digitization process it becomes impractical and costly to try to delineate these features at that scale. The photointerpreter makes a conscious decision to delineate them or they are lumped into the mangrove classes; digital processing automatically maintains their separation.

The utilization of classification systems also contributes to discrepancies in data updating. The NWI maps are based on the Cowardin system while the State of Florida uses a modified Anderson system tailored to state needs. In Figure 5, a 162 ha area defined by NWI as mangrove falls outside the spectral clusters we consider mangrove. In fact, this is a salt flat which has 30% or less mangrove and would never be classified as mangrove. To confuse the process further, this same area was called the equivalent of a salt flat in the 1950 NWI analyses and thus shows a misleading increase of 162 ha of mangroves within the same classification system.

The point to be made is trend analyses must be conducted with caution and with a full evaluation and understanding of the data being compared. In fact, of the 388 ha change between 1982 and 1987 less than 17 ha are due to real change (<1% change). If the original image used was TM rather than NWI then the data updating would not have the problems that have been identified. This does not indicate that one process is better than the other, just that they are different.

CLASSIFICATION SYSTEMS

The importance of the classification system cannot be under estimated when using satellite image processing for habitat delineation. This is something which must be addressed in the initial stages of a mapping program. Since we have been primarily mapping coastal wetlands we have chosen to tailor our classification to Florida wetlands by name. Thus we name a saltmarsh complex a saltmarsh and if we go to the next level of delineation we would name Juncus and Spartina as components of that complex. Our classification, at that point, could be cross referenced with either the NWI Cowardin system or the Anderson system. Because we are working with raster data at 30m spatial resolution we have categories that consist of marsh and water. These areas are often presented as a marsh/water category which is not used in most classification systems.

It has been our observation that the TM analyses can be better tuned to the Anderson system and can have major discrepancies with the Cowardin system. It is best to determine the limits of the classification systems relative to TM processing and develop a hybrid system. If this is not done, much effort can be spent attempting to force a classification of the data and reduce the ability to efficiently conduct trend analyses.

CONCLUSIONS

The Florida Marine Research Institute has developed and implemented a coastal mapping effort designed for efficient and cost effective mapping and monitoring of Florida's geographically expansive coastal wetlands. A combination of Landsat satellite imagery, aerial photography, ground truthing, and ancillary map data are used to produce digital maps from a Landsat TM map base. We have described, in a very general presentation, the techniques and concepts we employ in the map making and subsequent habitat trend analyses. The success of this effort has been based on the flexibility built into the standardization of the mapping process.

Many issues such as ground truthing and digital and hardcopy data distribution have not been discussed. All require substantial planning and can become major operational components of an effective program. We have also evaluated SPOT satellite data for mapping efficiency and do use SPOT data when higher resolution mapping is required. The spectral superiority (particularly the mid-infrared bands) and the lower costs of Landsat TM data make its use more advantageous for large geographic areas.

Although our habitat mapping effort is important, it has little long-term meaning if the habitat is not considered as part of an ecosystem. The wetlands are just one layer of information, out of many, that we are building in the Marine Resource Geographic Information System. Linkage to dredge and fill permits and other types of permits which allow us to reconstruct permitted habitat losses which cannot be mapped is being investigated. Concurrent with our mapping efforts we are conducting field research to quantitatively assess species utilization and production within the different habitats. All of these efforts will eventually provide the information necessary to implement an ecosystem approach to coastal resource management.

REFERENCES

Haddad, K.D. and B.A. Harris. 1985a. Use of remote sensing to assess estuarine habitats. Pp. 662-675 In O.T. Magoon, H. Converse, D. Minor, D. Clark, and L.T. Tobin (eds.), Coastal Zone '85, Proceedings of the Fourth Symposium on Coastal and Ocean Management, Vol. 1. New York. American Society of Civil Engineers. 1294 pp.

Haddad, K.D. and B.A. Harris. 1985b. Assessment and trends of Florida's marine fisheries habitat: an integration of aerial photography and thematic mapper imagery. Pp. 130-138 In S.K. Mengel and D.B. Morrison (eds.), Machine Processing of Remotely Sensed Data. West Lafayette, In. Purdue University. 370 pp.

Welch, R., T.R. Jordon, and M. Ehlers. 1985. Comparative evaluation of geodetic accuracy and cartographic potential of Landsat-4 and Landsat-5 thematic mapper image data. Photogram. Eng. and Remote Sensing 51(11):1799-1812.

Example of a MRGIS Application

Since inclusion of all the analyses conducted on the MRGIS is not feasible in this final report an example has been selected to demonstrate a single application. The application used data being included in the MRGIS data base for individual estuaries and was the result of a fisheries application request rather than the more common growth management application requests.

The Florida Marine Fisheries Commission is charged with developing rules for the states fisheries management. One of the common problems in the management and rule making process is the lack of information. The MRGIS has recently been presented to the Commission as a tool for providing information in a format better suited for certain types of data. A first application of the MRGIS in the fisheries management process is being focused on the evaluation of current estuarine shrimping areas relative to natural resources, bathymetry, nursery areas, and eventually to current rules and regulations.

Figure 6 depicts the MRGIS applications concept to the shrimping information data base. A primary management question concerns the potential impacts of shrimping on the natural resources, particularly seagrasses which grow in the shallower portions of our estuaries. Figure 7 depicts and summarizes the MRGIS analytical approach in determining shrimping areas that impact seagrasses and the depth of the seagrasses that are impacted. The results of this analysis provide the managers with pictorial and quantitative assessments of existing management impacts and the results of potential management decisions. Figures 8-12 depict data layers used in the analyses and the results for Apalachicola Bay. The figures are simplified and much reduced in scale for presentation purposes. Figures 8-10 show the data layers used in the analyses. Figure 11 presents the location of resources by depth which are within shrimping areas. This particular analyses includes both seagrasses and oyster reefs. Figure 12 depicts only seagrasses, within the shrimping areas, which are impacted and demonstrates that for Apalachicola Bay potential impacts are minimal.

Table 4 summarizes a similar analysis for Tampa Bay with quite different results. Tampa Bay has both bait and food shrimping and the areas fished are significantly different. Approximately 19,164 acres of bay bottom are bait shrimping area. Forty four percent of that area is comprised of seagrass and 90% of the seagrass occurs in depths of <3 ft.. If the Commission were to consider restricting shrimping to >3 ft. then 55% of the bait shrimping area would be eliminated while 90% of the seagrasses would be removed from the potential impact of bait shrimping. On the other hand food shrimping would still be allowed to occur over 98% of the exiting food shrimping areas. These types of analyses have not previously been available in fisheries management and the potential for improving the fisheries management and rule making process is substantial.

Interface Tabular Data to the MRGIS

A full link to DBASIII+ has been accomplished. The DER STORET and permit data bases were evaluated for linkage to the MRGIS. Although it appears to be technically feasible an evaluation of the data itself has been advised prior to expending effort in data conversion. Positional accuracies and certain aspects of the quality of data need to be evaluated. A full link to the DNR/USFWS manatee mortality data base has been completed. Approximately 66% of those data had to be upgraded for positional accuracy.

It appears that positional accuracy (i.e. location of the data point in UTM or Lat/Lon) is a pervasive problem in tabular data. This may be due to lack of quality control, technical difficulties in locating a ground point, data originally not planned for link to a GIS, and many other reasons. In many cases these limitations can be overcome by modifying the types of analyses conducted with the data. But it becomes difficult to use the MRGIS to determine the submerged bottom resources at the location of a manatee mortality in the Indian River Lagoon when many of the points fall on land, Interstate 95, and in New York.

Figure 13 depicts the Little Manatee River watershed and its tributaries and was produced digitally on the MRGIS. The boxes located in the watershed represent well water pumping stations. These data were converted from the SWFWMD mainframe data base and linked to the MRGIS though the DBAS interface. Each data record contains information on a given well (ie., pumping rates) and the fields of information within a record can be sorted for presentation and analyses relative to the map layers in the MRGIS. Numerous interactive analyses can be conducted with these or any other data with positional locations attached.

The DBAS interface continues to be upgraded with additional capabilities and is proving to be one of the most important software advances on the MRGIS and in raster data analyses.

Multi-spectral Video Imaging System

In this task we proposed to test the airborne imaging system for high resolution data collection using a small aircraft. This was not accomplished due to the priorities of the other portions of MRGIS operations. In particular, it was believed that the data dissemination effort were priority and we were backlogging requests which we considered important to fill. Test were conducted to determine the functionality of the equipment and future testing is planned.

Data Type	Source	Problems	Solutions
Base Map	SPOT Pancromatic satellite data	Geo-referencing to 1:24,000 USGS Quads.	Careful selection of control points to reduce spatial errors found on USGS quads
1950/1980 Land cover	FDNR & USFWS aerial photography	30 meter data	resampled to 10 meter data
1988 Land cover	SPOT Multi-spectral satellite imagery.	Statistical analyses difficult at 10 meter spatial resolution	Incorporate TM satellite data in both the statistical analyses phase and interpretation phase. Use NHAP color-IR aerial photography.
Soils	Soil Conservation Service & Manatee County, Fl.	Soils delineated on photo-based separates are not cartographically accurate.	Soils scientist re-compile soils maps onto 1:24,000 USGS Quads. Scan digitize for digital access
Elevation	USGS Quads and Southwest Fla. Water Managment District (SWFWMD)	5 ft. contours from USGS Quads are not adequate in a low relief watershed. SWFWMD has undigitized 1 & 2 ft. contours	Accept resolution of USGS data or digitize SWFWMD maps
Flood Maps	Federal Emergency Management Agency	Cartographically inaccurate and very general spatially	Use 3 point triangulation to digitize.
Future land-use plans	Hillsborough and Manatee Counties	Cartographically inaccurate and different classification schemes	Use 3 point triangulation. Cross-reference classification system
Drainage	Aerial photography	Time consuming interpretation	None

Table 1 : Sources, problems, and solutions for some of the data layers being entered on the MRGIS for the LMR.

Station	Upland Plant Communities	Wetland Plant Communities	Water	Agriculture Pasture Barren	Total
ST1	624	718	208	6,577	8,127
ST2	151	61	1	1,848	2,061
ST3	4,281	1,527	226	17,169	23,203
ST4	2,531	1,060	47	6,249	9,887
ST5	77	79	26	862	1,044
ST6	6,515	3,115	1,684	27,989	39,303
ST7	127	341	42	1,636 (urban)	2,146
Total Watershed	7,337	5,301	1,859	42,870	57,364

Table 2. Distribution, in hectares, of major land-cover types for the sub watershed drainage areas defined by the location of water quality stations. Note: ST7 is urban rather than Agriculture.

TABLE 3. List of MRGIS data requests and presentations (April 1989-Dec. 1989)

1. East Central Florida Regional Planning Council
2. Florida Department of Transportation
3. Department of Natural Resources - Terra Ceia Aquatic Preserve
4. Bionetics, Kennedy Space Center
5. Planning and Zoning Department, Volusia County
6. Environmental Management Dept., Pinellas County
7. West Side Fire Dept., Bradenton, FL
8. Tampa Bay Regional Planning Council
9. T.A. Herbert and Associates, Tallahassee, FL
10. Rookery Bay National Estuarine Research Reserve
11. American Friends Service Committee, Tampa Bay Area
12. Committee on Environmental Regulation, Tallahassee, FL
13. University of Florida, Zoology Dept.
14. Florida Oceanographic Society
15. Department of Natural Resources - Bureau of Aquatic Preserves
16. Wakulla County Planning Dept.
17. The Conservancy, Naples, FL
18. State of Florida - Office of the Governor
19. USDA Soil Conservation Service
20. Department of Natural Resources - Marathon Laboratory
21. NOAA/National Marine Fisheries Services
22. Bureau of Seafood Marketing
23. Earth Observation Satellite Company
24. SPOT Image Corporation
25. US EPA, Washington
26. Army Corp., Mobile District, Alabama
27. Duval Audubon Society
28. State of Florida Information Resource Commission
29. DNR Executive Office
30. City of Naples
31. Commission on the Future of Floridas Environment
32. State of Florida Auditor Generals Office
33. Federal/State Gulf of Mexico Program
34. Technical Resources Inc.
35. Office of the Governor/Office of Planning and Budget
36. Tampa College "River Quest" <u>presentation</u>
37. Marine Mammal Commission <u>presentation</u>
38. Nichols State Univ. La <u>presentation</u>
39. Florida Council of Yacht Clubs <u>presentation</u>
40. SPOT Conference Orlando <u>presentation</u>
41. Univ. of Fla.
42. Fla. Institute of Technology
43. South Florida Water Management District
44. South West Florida Water Management District
45. Eckerd College
46. Manatee County
47. Coastal Zone 89 <u>presentation</u>
48. Federal Interagency Habitat loss and modification working group (including <u>presentation</u>)
49. Texas Dept. of Wildlife and Parks
50. NOAA/Strategic Assessment Branch
51. NOAA/National Oceanographic Data Center <u>presentation</u>

Table 3. Continued

52. NOAA/National Ocean Survey/Coastwatch
53. Chesapeake Bay Task Force <u>presentation</u>
54. FL. A&M University
55. Univ. S. Florida Regional GIS Workshop <u>presentation</u>
56. Division of Forestry <u>presentation</u>
57. GIS/LIS
58. Florida Marine Fisheries Commission
59. Maynard Hiss
60. University of Rhode Island
61. U.S. Fish and Wildlife Service, Atlanta
62. US EPA Atlanta
63. Dauphin Island Sea Lab, Alabama
64. Suwannee River Water Management District
65. N.W. Florida Water Management District
66. Tampa Tribune
67. St. Petersburg Times
68. Bradenton Herald
69. Miami Herald
70. New York Times
71. Time Magazine
72. Massachusetts Institute of Technology
73. USFWS National Wetlands Research Center
74. Dept. of Community Affairs
75. Senator James Kirkpatrick

TAMPA BAY

DEPTH OF SEAGRASSES WITHIN SHRIMP HARVEST AREAS

BAIT SHRIMPING

DEPTH	SEAGRASS ACRES SHRIMPED		NON-SEAGRASS ACRES SHRIMPED		TOTAL AREA SHRIMPED	
< 3 Feet	7582	90%	2831	27%	10,413	54%
3 to 6 Feet	0347	04%	4556	42%	4,903	26%
> 6 Feet	0535	06%	3313	31%	3,848	20%
Total	8464	100%	10,700	100%	19,164	100%

IF BAIT IS REGULATED BY DEPTH

DEPTH	SHRIMPING AREA REDUCED
< 3 Feet	54%
3 to 6 Feet	26%
> 6 Feet	20%

FOOD SHRIMPING

DEPTH	SEAGRASS ACRES SHRIMPED	NON-SEAGRASS ACRES SHRIMPED	
< 3 Feet	0	0040	0%
3 to 6 Feet	0	0575	2%
> 6 Feet	0	32,209	98%
Total	0	32,824	100%

Table 4. Summary of MRGIS analyses results to determine the amount and depth of seagrass trawled during shrimping efforts in Tampa Bay.

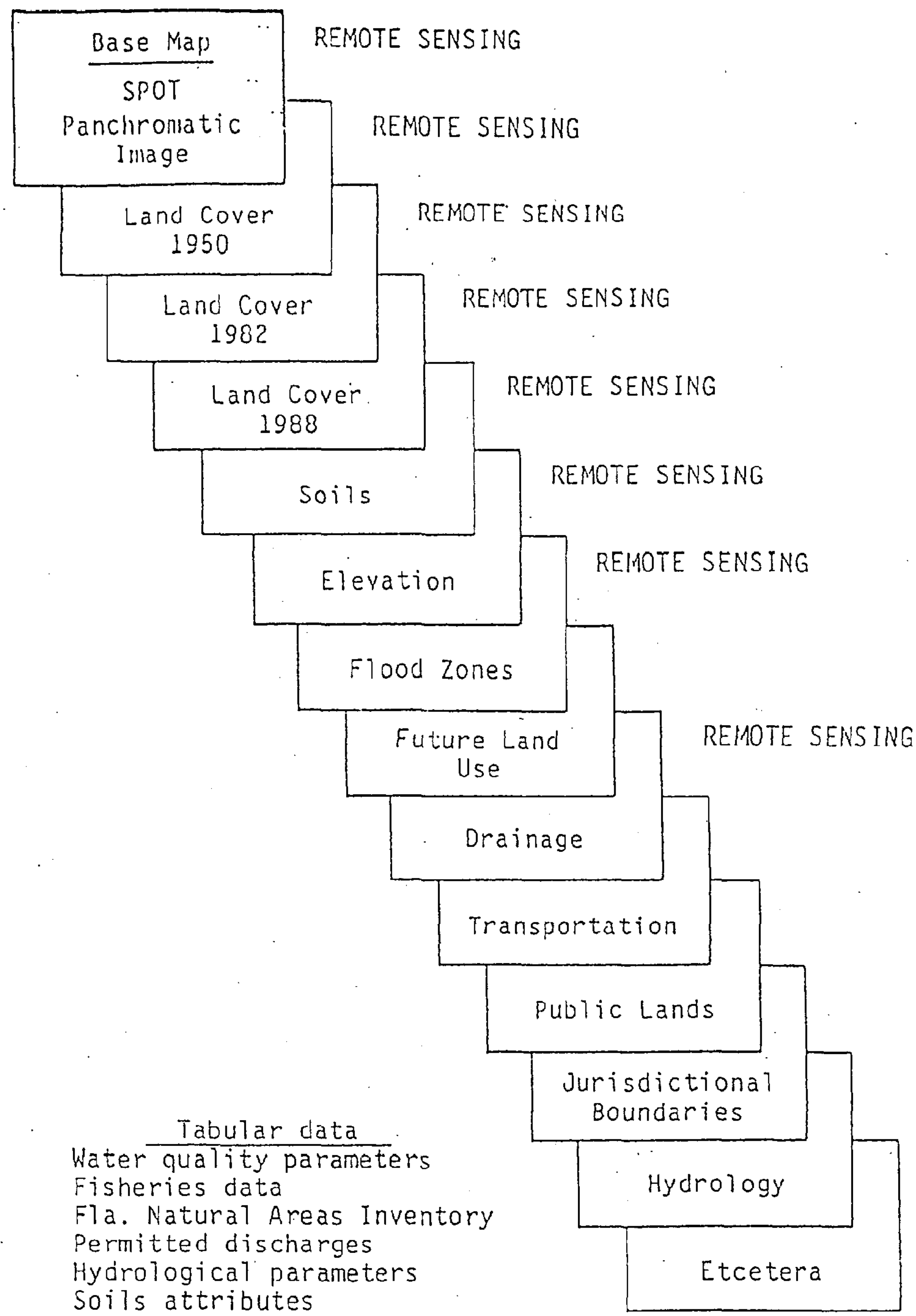


Figure 1 : Some of the data layers being implemented on the MRGIS for the LMR watershed. Those layers dependent on remote sensing are noted. Tabular data to be linked to the data layers are also noted.

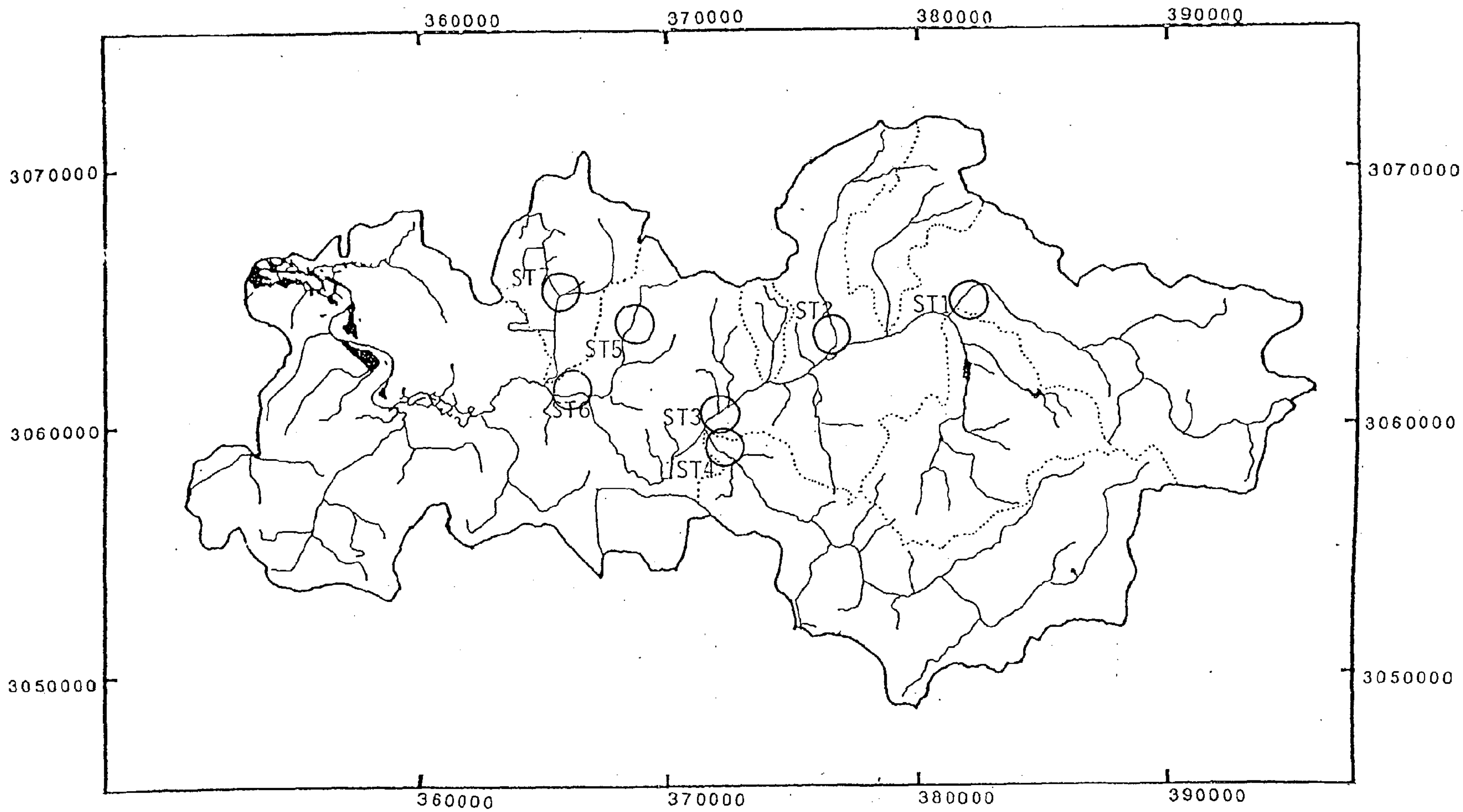


Figure 2 : Water quality stations within the Little Manatee River watershed. Dotted lines represent sub-basins.

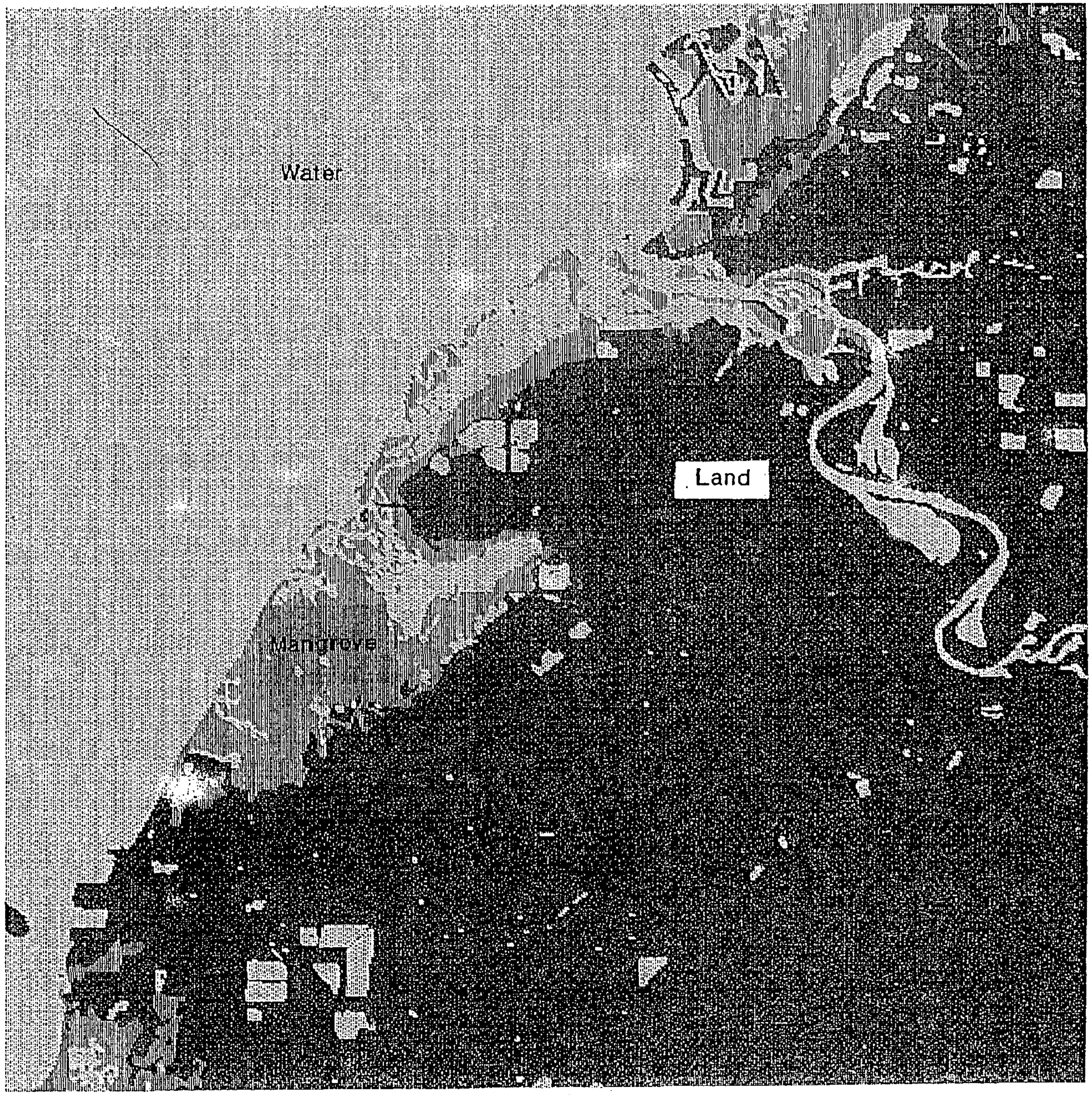


Figure 3 : 1982 NWI classification of mangroves for a portion of Tampa Bay.

Figure 4 : 1987 Thematic Mapper data within the area designated as mangroves in 1982. Bright areas and linear features such as roads represent discrepancies in interpretation and classification of the data.

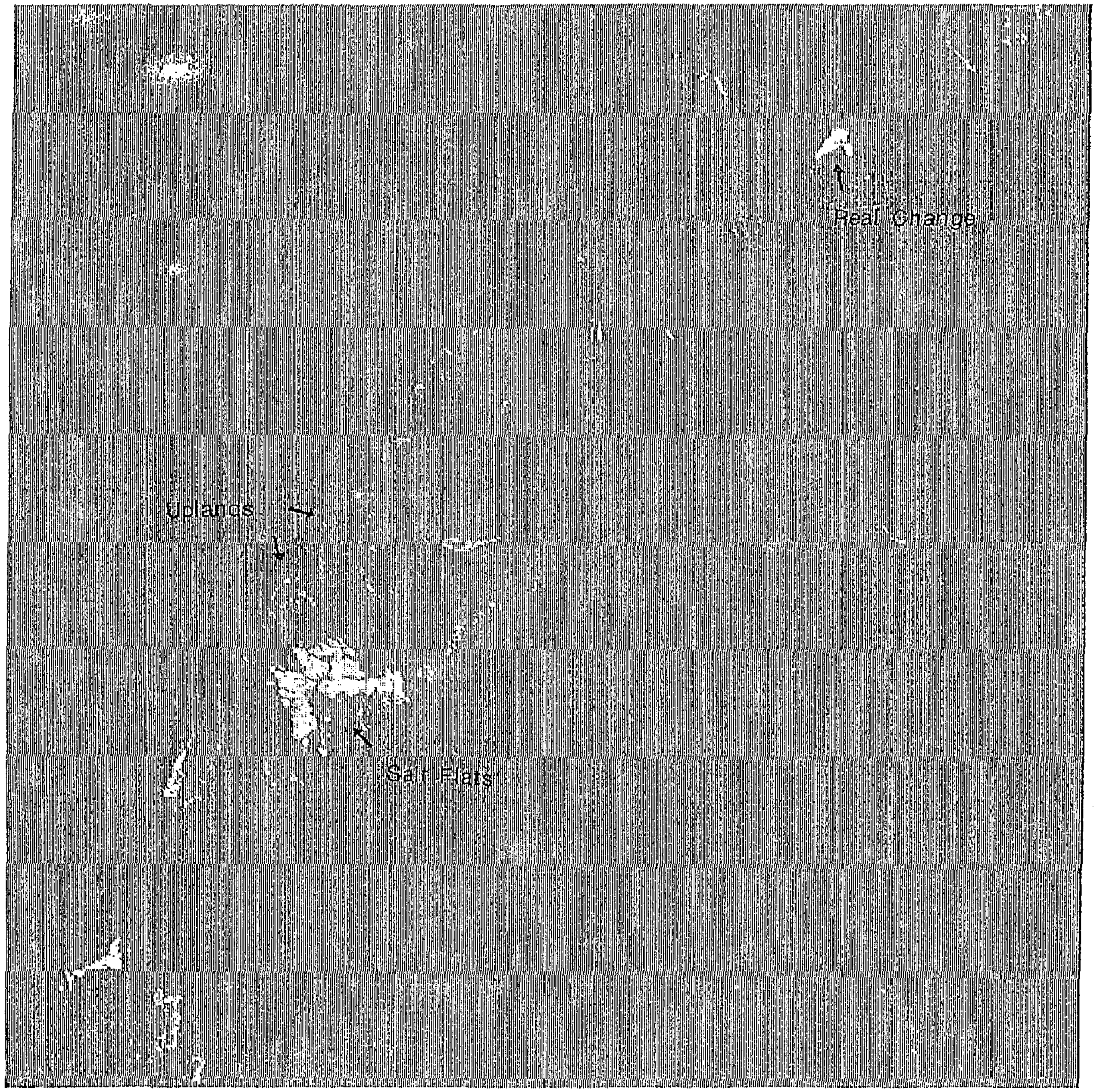


Figure 5 : 1987 Thematic Mapper data classified as mangroves in 1982, but not classified as mangrove in 1987.

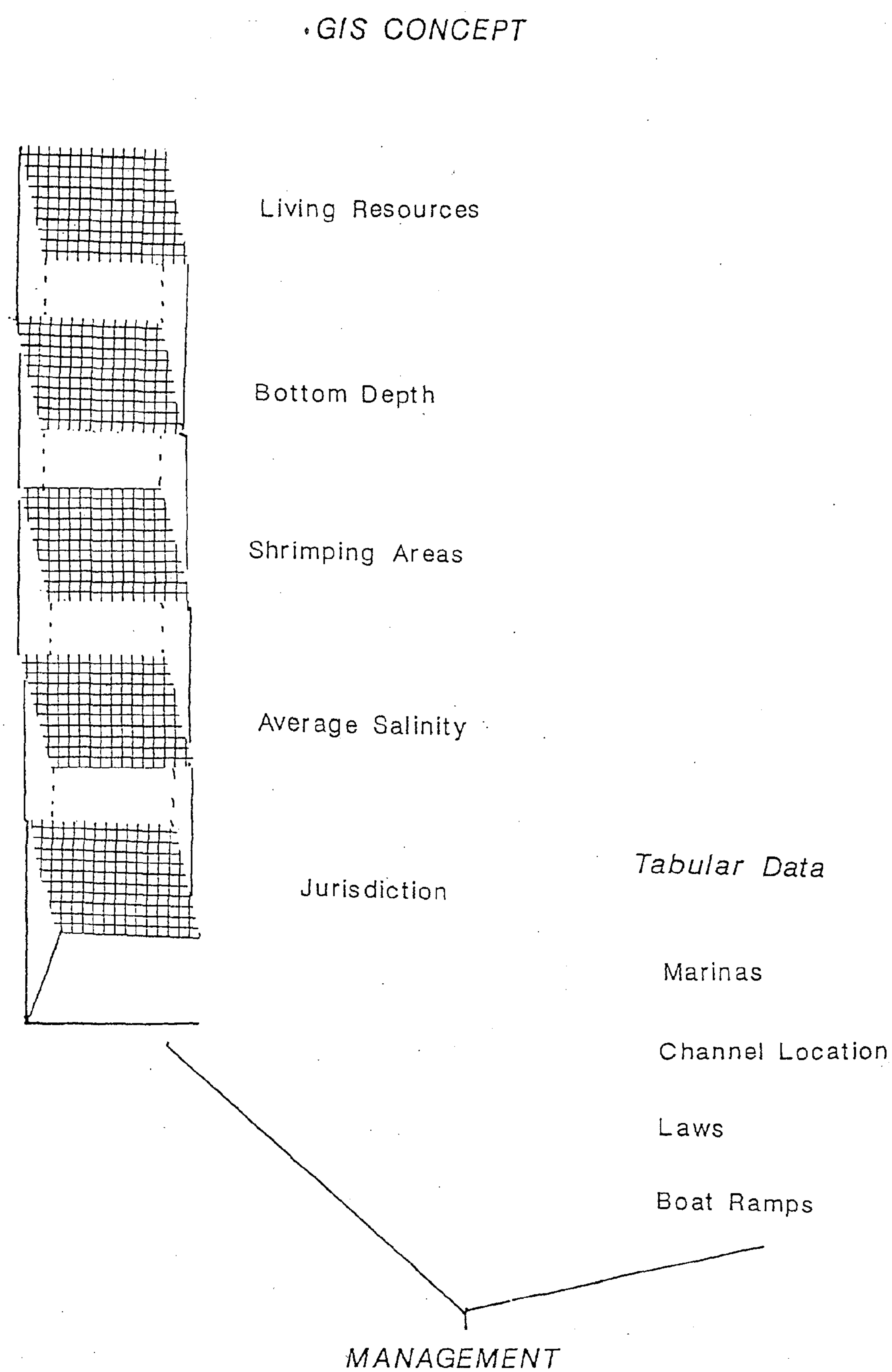


Figure 6 : Conceptual application of GIS to shrimp management.

MRGIS ANALYSIS

PROGRAM STATEMENTS

```
10 IF (CH4-17) 20, 50, 30
20 IF (CH4-15) 30, 50, 50
30 CHO=0
40 RETURN
50 IF (CH1-04) 60, 60, 60
60 CHO=CH2
70 RETURN
80 END
```

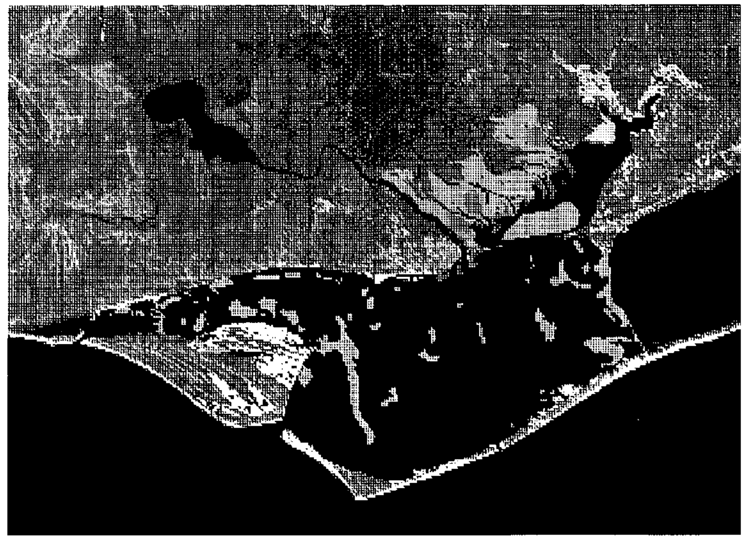
WHAT THE PROGRAM DOES

10 IF THE AREA IS A SHRIMPING AREA LOOK AT THE DEPTH; IF NOT, LEAVE AS IS.

20 IF DEPTH IS < 3 FEET TO > 6 FEET, LOOK AT THE BOTTOM RESOURCE.

30 IF THE BOTTOM RESOURCE IS SEAGRASS, THEN PRINT THE DEPTH OF THE SEAGRASS.

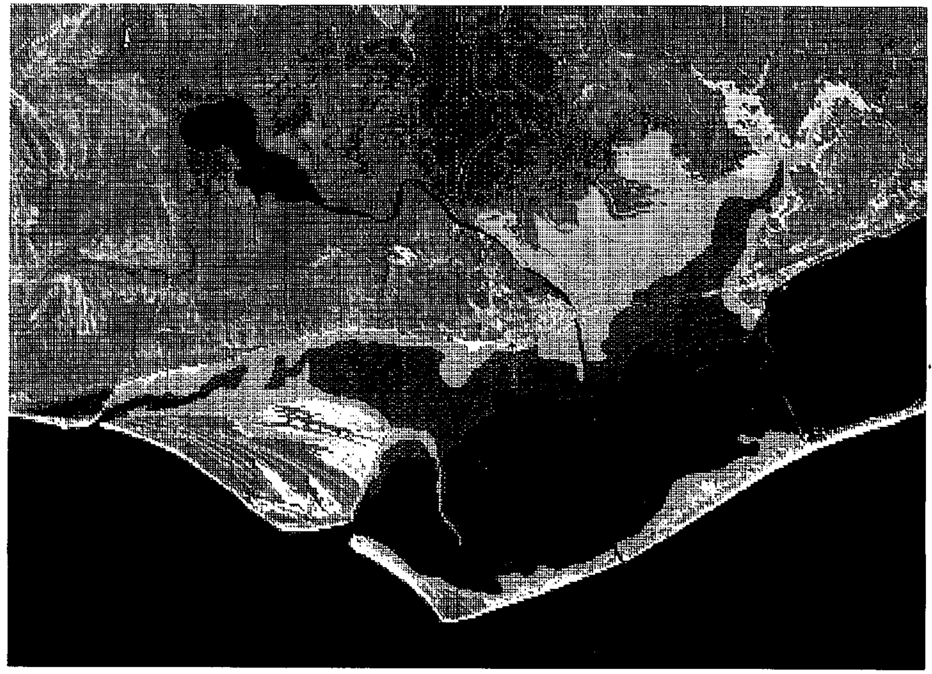
Figure 7. Query and summary of an analysis to determine depth of seagrasses that are trawled for shrimp.



APALACHICOLA BAY NATURAL RESOURCES

- SEAGRASS
- FRESH GRASS
- OYSTERS
- MARSH

Figure 8



DEPTH CONTOURS

DEPTH < 3 FT	2,228 HA
DEPTH 3–6 FT	2,248 HA
DEPTH > 6 FT	3,406 HA
CHANNEL MARKERS/BRIDGES	

Figure 9

SHRIMPING AREA

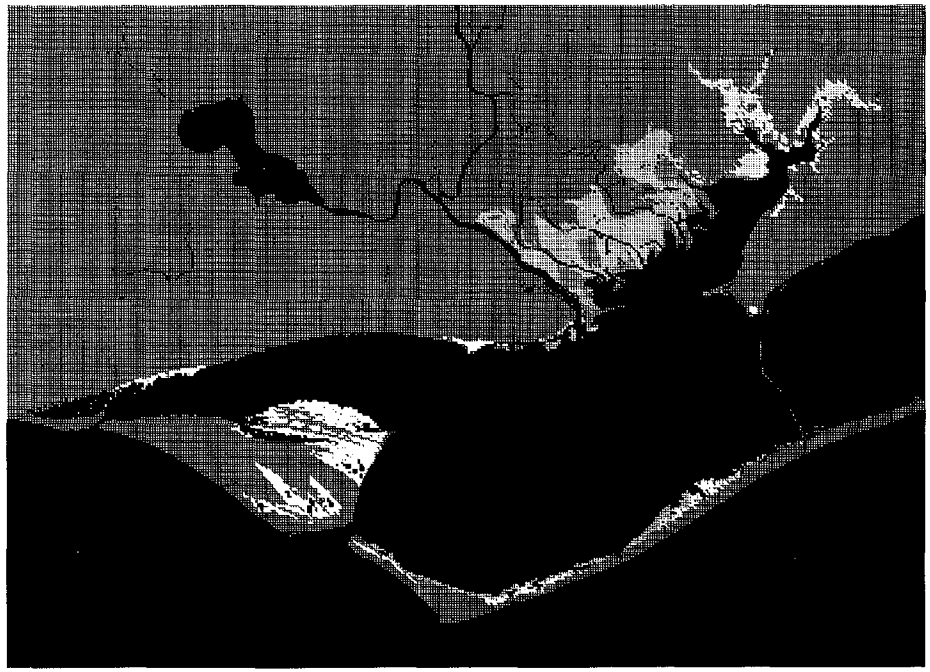
●	SMALL WHITES & BROWNS	2,377 HA
●	WHITES & BROWNS	805 HA
●	LARGE WHITES & BROWNS	3,332 HA
○	MARSH NURSERY AREA	
●	GRASS NURSERY AREA	

Figure 10

DEPTH OF SUBMERGED RESOURCES
IN SHRIMPING AREAS

DEPTH < 3 FT	343 HA
DEPTH 3–6 FT	277 HA
DEPTH > 6 FT	123 HA
CHANNEL MARKERS/BRIDGES	

Figure 11



DEPTH OF SEAGRASS WITHIN SHRIMPING AREAS

●	DEPTH < 3 FT	127 HA
●	DEPTH 3–6 FT	2 HA
●	DEPTH > 6 FT	0 HA

Figure 12

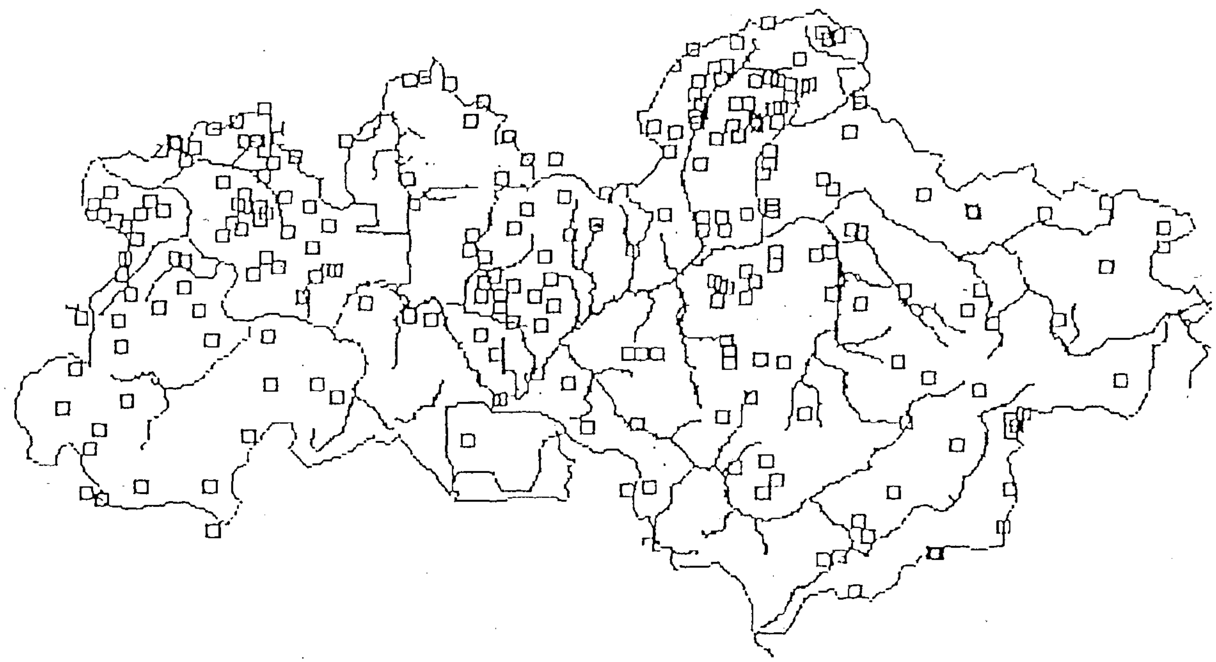


Figure 13: Locations of water well pumps in the Little Manatee River watershed. These data were imported into the MRGIS data base through the DBAS link.

Task II. Methodologies for measuring habitat carrying capacity and fisheries utilization.

CARRYING CAPACITY

Gear Testing:

This activity continued in Cockroach Bay during 1989 with an emphasis on quantitative methods for sampling juvenile and small adult fishes in seagrass beds as well as unvegetated shallow-water habitats. As mentioned in the April 1989 Final Report, the preferred type of sampling gear for seagrass beds (based on previous testing) was a 1 m^2 roving dropnet (RDN). This sampling gear is, however, highly selective for demersal and semi-demersal species. Thus, in 1989 we began testing two types of sampling gear designed to quantitatively collect pelagic species: a 120 m pull-through seine (PTS) and a 1 m^2 bow-mounted pushnet (BMPN).

The RDN and associated sampling methodology were described in the 1986, 1987, and April 1989 Final Reports. RDN sampling was conducted once or twice per month with five to twelve drops being executed on each sampling date.

The PTS is similar to the long-haul seine described by Kjelson and Johnson (1975). Our version of this net is 122 m long by 2.4 m deep with a 2.4 by 2.4 by 2.4 m bag at one end and a seine pole attached to the bag end. The net is deployed in a circular configuration by boat. When the circle is completed, a seine pole is driven into the substrate beside the attached pole but on the outside of the net. Thus, as the boat continues closing the circle the net is forced between two seine poles.

This procedure reduces escapement by maintaining the net in an upright position with weights on or near the substrate and floats at the surface. The circle is closed until only the bag portion of the net remains, and this portion is then gathered onto the boat. Nineteen sets were conducted with this net during June, August, and September 1989.

The BMPN is similar to that described by Kriete and Loesch (1980). Our net has an opening of 1 m^2, is 3 m long, and is constructed of 3.2 mm mesh. It is attached to an aluminum frame that is fitted to the bow of a 5 m outboard boat and is equipped with a flow meter. Testing of this sampling gear was quite preliminary during the time period covered by this report. Only 11 samples were collected in July and August, and details such as tow duration, sampling depth, etc., are still being evaluated. For this reason the only comparison of this gear with the other two will be in terms of species richness and relative abundance of dominant species.

Species Richness and Abundance:

Although final identifications are not complete for all samples collected during the report period, preliminary results can be presented for our three types of sampling gear. Number of species collected by each sampling gear were as follows: RDN, 35 species; PTS, 49 species; and BMPN, 16 species. The latter total was undoubtedly affected by the paucity of samples. The RDN total compared favorably with the 1988 total of 38 species.

Rank abundance of species indicated relatively greater abundance of pelagic species in PTS and BMPN samples and greater abundance of demersal and semi-demersal species in DN samples (Table 1). Abundant pelagic species included Anchoa mitchilli, Harengula jaguana, and Opisthonema oglinum (see Appendix A for common names of fish species). A. mitchili was obviously of relatively greater importance in PTS and BMPN samples, only 1 specimen of H. jaguana was collected by the RDN, and no specimens of O. oglinum were collected by the RDN. Chloroscombrus chrysurus is a schooling species probably similar in habits and habitat to the above-mentioned pelagic species and was only important in BMPN samples. Demersal or semi-demersal species (i.e., those generally associated with the bottom or some other substrate such as seagrass blades) included Bairdiella chrysoura, Lagodon rhomboides, Eucinostomus spp., Lucania parva, Syngnathus scovelli, and Gobiosoma spp. Four members of this group were the top four species in abundance in RDN collections.

Density Comparisons:

Comparisons of densities for selected species in August 1989 RDN versus PTS samples again indicated the marked difference in selectivity of these two types of sampling gear (Table 2). Species that we have utilized in this comparison include most of those listed among the dominants in Table 1 plus the economically valuable species Cynoscion nebulosus. Mean calculated densities were 2.8 and 16 times greater, respectively, in PTS samples for the pelagic species A. mitchilli and H. jaguana, while another pelagic species, O. oglinum, ranked among the top few species in density in PTS samples but was absent from RDN samples. On the other hand, densities for six demersal or semi-demersal species ranged from 3.2 to more than 30 times greater in RDN than in PTS samples.

In summary, our data indicate that accurate measurement of habitat carrying capacity in areas such as Cockroach Bay would be impossible with either the RDN or PTS alone, although a combination of these two types of gear may yield reasonable estimates fish populations densities in such areas. The eventual role of the BMPN in these studies is unclear at this time. Data collected by the RDN to date may be used to make reasonable predictions regarding densities of several demersal or semi-demersal species to be expected per area of a Tampa Bay seagrass bed.

HABITAT UTILIZATION

Methods:

The Little Manatee River was sampled approximately biweekly from January through September 1989. Fishes were sampled with a 22.7 m bag seine (15 sites per sampling date), a 9 m bag seine (2 sites), and a 6.1 m otter trawl (11 sites). In 1988 we used a 3.6 m otter trawl and did not use the smaller seine. Mesh size in both seines and in the cod end liner of the trawl was 3.2 mm. Station locations ranged from the mouth of the river (Station 1, Fig. 1) upstream to nearly permanent freshwater (Station 6, Fig. 1). During the nine-month period covered by this report, 300,058 specimens (representing at least 87 species) were collected, identified, and measured.

Seven physical/chemical parameters were measured at each of the six sampling stations on each sampling data (see April 1989 Final Report). The discussion below will emphasize salinity, water temperature, dissolved oxygen, and pH. Values for these parameters over the first nine months of 1989 will be presented and compared with the same period in 1988.

Fish community data will be presented below at two different levels. First, we will present a brief comparison of the entire community in 1988 versus 1989. Second, we will concentrate on 17 species that are either numerically dominant or of considerable economic value. These species will be compared and contrasted in terms of seasonal and spatial distribution and distribution in relation to salinity. Wherever possible, data will be compared between 1988 and 1989. This presentation is meant to illustrate just some of the ecological data available in our data set. Distribution of fishes in the Little Manatee River is obviously not determined by a single factor such as salinity, and, upon completion of the 1989 data set, we will begin multivariate analyses in hopes of determining the relative importance of various habitat variables in determining the distribution of key species in this system.

We would like to mention at this point that our specimens and data regarding exotic fishes of the genus _Tilapia_ are currently being examined by J. D. Williams and D. Jennings of the U. S. Fish and Wildlife Service in Gainesville, Florida. _Tilapia_ spp. are well-established and often abundant in some Little Manatee River collections, and we believe that they could have a significant impact on fish community dynamics in this system. Dr. Williams and Ms. Jennings are conducting a nationwide survey of *Tilapia* populations and are among the few persons qualified to identify the various species (especially as juveniles).

Station Descriptions:

All stations were at the same locations as presented in the April 1989 Final Report with some minor variations in sampling scheme and exact sample sites (Fig. 1). The number of trawl tows was decreased from three to two at Stations 1, 3, and 4 and from three to one at Stations 5 and 6. At Station 3 the 22.7 m seine was utilized at 2 sites on oppostie banks of the river (former sites 3A and C), while a third seine haul was conducted with the 9 m seine just inside the mouth of a small creek entering the river at Sun City Heritage Park. At Station 4 an additional seine haul was conducted with the 9 m seine in a small cove just upstream of the Interstate 75 bridge. And, finally, the number of seine hauls at Stations 5 and 6 was reduced from three to two (on opposite banks of the river). All of the deletions were made in an effort to reduce time wasted in unproductive or redundant sampling and seem to have had little effect on the overall scheme of fish distribution represented in our data base. The two new sites were added in an effort to include microhabitats not sampled in the previous scheme.

Physical/Chemical Data:

Salinity values varied markedly over this period, and seasonal patterns often differed from those exhibited in 1988. At sites 1A and 1C there was less stratification between surface and bottom salinities in 1989, and the decrease from high summer values occurred in July instead of August (Figs. 2 and 3). Overall, however, the salinity range was relatively restricted and values were generally higher at these sites in 1989. Although the data set is incomplete for 1989, patterns at sites 2A and 2B seemed similar between years with relatively low (but fluctuating) values in winter and spring, high values in mid-summer, and relatively low values in late summer-early fall (Figs. 4 and 5). Surface-bottom stratification was not pronounced in either year, and salinity ranges were similar although values never reached as low as 0 ppt in 1989. Site 2C also exhibited similar patterns between years, but stratification was much greater in 1988 (Fig. 6). Also, surface salinities often ranged much lower in 1988, especially in spring and late summer-early fall. Site 3B was not stratified in either year and showed a late spring-summer increase in salinity in both years (Fig. 7). Values did, however, fluctuate more widely between sampling periods in 1989 and fewer zero or near zero values were recorded. Site 4A was also poorly stratified with values peaking in summer (Fig. 8). Again, however, fewer zero values were recorded in the low salinity periods. At sites 5A and 6A stratification and seasonal pattern were similar between years, but the summer salinity peak was higher in 1989 (Figs. 9 and 10).

In fact, the May and June values for site 6A were the only non-zero salinity values that we have recorded at that site. In summary, salinity patterns were somewhat similar between 1988 and 1989, but values were often somewhat higher in the latter year, especially at upstream stations.

As in 1988 dissolved oxygen values generally peaked in winter-spring, decreased during summer, and often increased somewhat during fall (Figs. 11-13). Stratification was greatest at sites 2C and 4A, where bottom values were much lower than surface values on several dates, and seasonal dissolved oxygen depression was again greatest at sites 2C, 3B, and 4A.

Temperature patterns were nearly identical among stations and were similar between years (Figs. 14-16). In both years temperatures increased from January through May and remained at a stable 25 to 30° C through September. The major difference between years was in the minimum recorded temperatures: as low as 8° C in 1988 versus 16° C in 1989. Temperature stratification was minimal.

Values for pH exhibited little vertical stratification but varied markedly among seasons and stations as well as between years (Figs. 17-19). At Stations 1 and 2 values fluctuated but were notably lower from winter through mid-summer than in late summer-early fall. This pattern was somewhat reversed in 1988 and fluctuations were much less marked. At Station 3 the above-mentioned seasonal pattern was not evident, and fluctuations were, again, greater than in 1988. At Station 4 pH decreased in May and June, increased markedly in July, and decreased again in late July through September. In 1988 values were relatively stable over these months. At Stations 5 and 6 pH values exhibited wide fluctuations with peaks in winter, spring, and summer and generally low values in late summer-fall. The peak values in 1989 (pH>8) were never reached during this same time period in 1988 although similar values were recorded in October through December.

Fish Community:

Despite the incomplete 1989 data set, the dominant species in the Little Manatee River were similar in 1988 and 1989 at the two most downstream stations but varied more upstream (Table 3). At Station 1 the dominant five species were exactly the same in both years. Station 2 rankings were only changed by the reversal of *Eucinostomus* spp. and *Leiostomus xanthurus*. At Station 3 two species that were relatively more important further upstream in 1988, *Gambusia affinis* and *Poecilia latipinna*, entered the top five in 1989 replacing *Eucinostomus* spp. and *Brevoortia* spp. This trend was directly related to the addition of the new seine site in the creek mouth at this station: most *G. affinis* and *P. latipinna* were collected at this site. We must also mention, however, that several large samples of both *Eucinostomus* spp. and *Brevoortia* spp. were preserved in 1989 for verification of identification and that addition of these samples to the data base might affect the rankings of these two groups at several stations. The top five species at Station 4 were nearly identical (with some rearrangement) except for the fact that

Eucinostomus spp. replaced Brevoortia spp. At Station 5 gobies became more important in 1989 with Gobiosoma spp. and Microgobius gulosus entering the top five list. Finally, at Station 6 four of the top five species are identical but M. gulosus replaced Fundulus seminolis. In both years perhaps the most striking factor in these data was the overriding numerical importance of A. mitchilli over the entire estuarine portion of this river.

Distribution of 17 selected fish species among 16 salinity categories exhibited reasonably good consistency between years (Table 4). Five species (Fundulus seminolis, Lucania goodei, Gambusia affinis, Poecilia latipinna, and Trinectes maculatus) exhibited a strong preference for fresh or oligohaline waters (categories 0 to ca. 3), while four species (Fundulus similis, Lagodon rhomboides, Bairdiella chrysoura, and Cynoscion nebulosus) displayed a preference for mesohaline to polyhaline waters (ca. category 4 and above). Of the remaining eight species, Microgobius gulosus and Centropomus undecimalis were most common in freshwater but ranged widely along the salinity gradient; Menidia spp. and Leiostomus xanthurus were somewhat more abundant in more saline waters but were also widely distributed; and Anchoa mitchilli, Cynoscion arenarius, Sciaenops ocellatus, and Mugil cephalus were scattered throughout mostly the freshwater to mesohaline portions of the spectrum. Most of the differences in salinity distribution between years were slight, and most were in the form of a slight shift towards higher salinities in 1989. In some cases these differences might reflect the slightly higher salinities throughout the study area in 1989, but in four of the most obvious cases (i.e., A. mitchilli, G. affinis, P. latipinna, and C. undecimalis) these differences were directly related to the addition of the creek site at Station 3 (all four species were collected in significant numbers at this site). Furthermore, the data from this site may be misleading since salinity was recorded outside of the mouth of this creek, and the seine was pulled into the creek. Salinities will be recorded well inside the creek in 1990.

Distribution of these same 17 species among our six sampling stations was reasonably consistent with the salinity data presented above and compared favorably between years (Table 5). The five low-salinity forms were obviously most abundant at Stations 4 through 6. Pronounced differences between years were noted in G. affinis and P. latipinna: in both species relative numbers were much higher at Station 3 in 1989 than in 1988. This trend was, again, directly related to the addition of the creek site at Station 3. Among the four mesohaline to polyhaline forms, more than 50% of the specimens were collected at Station 1 in both years. This association was most pronounced in L. rhomboides, especially in 1989. None of these species demonstrated a pronounced expansion of range due to the slightly higher overall salinities in 1989. Of the remaining eight species A. mitchilli was most common at Stations 3 and 4 but was relatively numerous in at least one of the years at each of Stations 1 through 5, Menidia spp. were most common at Stations 1 and 2 but were also relatively numerous at Stations 3 and 4, C. undecimalis was most numerous at Stations 3 and 4 with relative numbers at Station 2 being greater in 1988 than in 1989, _C. arenarius_ was most common at Station 3 in both years with significant numbers only at Stations 1 through 4, _L. xanthurus_ was most numerous at Stations 2 and 3 in 1988 and Stations 1 and 3 in 1989 with significant numbers only at Stations 1 through 4, _S. ocellatus_ was concentrated at Stations 2 through 3 in both years, _M. cephalus_ was most numerous at Stations 2 and 3 in 1988 and at Stations 3 and 4 in 1989, and _M. gulosus_ was most numerous at Stations 4 and 5 in 1988 and at Stations 4 and 6 in 1989 with significant numbers at Stations 2 through 6. Again, none of these distributional patterns indicated a marked shift related to the generally higher salinities in 1989.

Numbers of specimens collected per month for some of these same species demonstrated some pronounced seasonal trends in abundance and generally agreed fairly well between years (Figs. 20-23). Periods of peak abundance usually represented peak juvenile recruitment into the river. Among the species figured, _L. rhomboides_, _L. xanthurus_, and _M. cephalus_ reached peak abundance in winter and spring; _S. ocellatus_ peaked in fall and early winter; and _B. chrysoura_, _C. arenarius_, _C. nebulosus_, and _M. gulosus_ peaked from late spring through early fall. _B. chrysoura_ seasonal numbers were distinctly bimodal with peaks in May and August-September in both years. Finally, peak abundances for several species (i.e., _C. arenarius_, _C. nebulosus_, _L. xanthurus_, _M. cephalus_, and _M. gulosus_) ranged from one to two months earlier in 1989 than in 1988.

Mean standard length of specimens captured at each station exhibited moderate to pronounced patterns of differential size distribution in several species, and these patterns were generally consistent between years (Fig. 24). Larger specimens of *A. mitchilli* and *F. similis* were generally found at the river mouth. Larger *C. arenarius*, on the other hand, exhibited a marked tendency to occur further upstream, and this tendency remained obvious in both years when the data were analyzed for indiviudal months during peak recruitment (Fig. 25).

In conclusion, distributional patterns of fishes in the Little Manatee River were fairly consistent between years despite the incomplete status of the 1989 data set. The higher overall salinity values for 1989 were not reflected in any wholesale changes in distribution among the species considered in detail (although a close examination of the data for Station 6 did indicate a reduction in numbers of some of the freshwater species during the May and June period of high salinity). We would predict, however, that such wholesale changes would occur with more radical interannual differences in salinity patterns. Finally, as we mentioned above, it was obvious that a variety of factors controlled the distribution of fish species in this riverine system and that multivariate analyses along with integration of these data with MRGIS habitat information will be necessary to obtain an understanding of observed patterns.

LITERATURE CITED

Kjelson, M. A., and G. N. Johnson. 1975. Description and evaluation of a long-haul seine for sampling fish populations in offshore estuarine habitats. Proc. 28th Ann. Conf. Southea. Assoc. Game Fish Comm. 1974: 171-179.

Kriete, W. H., Jr., and J. G. Loesch. 1980. Design and relative efficiency of a bow-mounted pushnet for sampling juvenile pelagic fishes. Trans. Am. Fish. Soc. 109(6): 649-652.

Table 1: Numerically dominant species in collections made in Cockroach Bay in 1989. Acronyms for different types of sampling gear and complete species names defined in text.

BMPN	#	RDN	#	PTS	#
A. mitchilli	310	L. rhomboides	1145	A. mitchilli	64329
B. chrysoura	182	L. parva	407	B. chrysoura	6363
C. chrysurus	35	S. scovelli	204	H. jaguana	5176
L. rhomboides	23	Gobiosoma spp.	166	Eucinostomus spp.	1487
Eucinostomus spp.	21	A. mitchilli	161	O. oglinum	1115

Table 2: Density calculations for selected species based on August 1989 RDN and PTS samples (#/ m^2). Three sample dates/ gear. Full species names in text.

	RDN		PTS	
Species	Mean	Range	Mean	Range
A. mitchilli	4.57	0.31-10.2	12.59	<0.01-35.78
H. jaguana	0.03	0.00- 0.10	0.48	0.10- 1.24
O. oglinum	0.00	----------	0.18	0.00- 0.52
S. scovelli	0.22	0.06- 0.40	<0.01	---------
B. chrysoura	0.64	0.50- 0.71	0.20	0.07- 0.38
C. nebulosus	0.07	0.00- 0.13	0.01	<0.01- 0.03
Eucinostomus spp.	0.42	0.00- 0.81	0.04	<0.01- 0.10
L. rhomboides	0.64	0.38- 0.80	0.05	0.02- 0.07
Gobiosoma spp.	0.30	0.00- 0.71	<0.01	---------

Table 3: Most abundant fish species from six sampling stations in the Little Manatee River; 1988 vs. 1989.

1988	Total collected	1989	Total collected
	STATION 1		
Menidia spp.	14,141	*Menidia* spp.	31,205
Anchoa mitchilli	11,479	*Anchoa mitchilli*	28,897
Lagodon rhomboides	7,662	*Lagodon rhomboides*	8,395
Eucinstomus spp.	3,356	*Eucinostomus* spp.	5,702
Leiostomus xanthurus	2,972	*Leiostomus xanthurus*	3,825
	STATION 2		
Anchoa mitchilli	36,342	*Anchoa mitchilli*	19,898
Menidia spp.	10,798	*Menidia* spp.	15,291
Leiostomus xanthurus	5,061	*Eucinostomus* spp.	2,668
Eucinostomus spp.	4,142	*Leiostomus xanthurus*	695
Fundulus similis	1,016	*Fundulus similis*	633
	STATION 3		
Anchoa mitchilli	48,034	*Anchoa mitchilli*	43,899
Menidia spp.	7,590	*Menidia* spp.	9,864
Leiostomus xanthurus	5,071	*Gambusia affinis*	6,068
Eucinostomus spp.	3,814	*Poecilia latipinna*	2,067
Brevoortia spp.	1,674	*Leiostomus xanthurus*	1,080
	STATION 4		
Anchoa mitchilli	64,731	*Anchoa mitchilli*	48,719
Gambusia affinis	11,042	*Menidia* spp.	6,727
Brevoortia spp.	8,240	*Gambusia affinis*	3,278
Menidia spp.	6,472	*Trinectes maculatus*	2,250
Trinectes maculatus	3,011	*Eucinostomus* spp.	1,516
	STATION 5		
Gambusia affinis	21,162	*Anchoa mitchilli*	8,225
Anchoa mitchilli	18,510	*Gambusia affinis*	3,794
Trinectes maculatus	7,470	*Trinectes maculatus*	2,175
Brevoortia spp.	4,814	*Gobiosoma* spp.	1,687
Poecilia latipinna	4,569	*Microgobius gulosus*	474
	STATION 6		
Anchoa mitchilli	15,117	*Anchoa mitchilli*	6,846
Trinectes maculatus	9,055	*Gambusia affinis*	2,201
Gambusia affinis	9,046	*Trinectes maculatus*	2,135
Lucania goodei	2,252	*Lucania parva*	725
Fundulus seminolis	2,081	*Microgobius gulosus*	693

Table 4. Distribution of selected fish species in the Little Manatee River in relation to surface salinity category, 1988 and 1989. Categories as follows: 0) 0.0-0.5 , 1) 0.6-2.0, 2) 2.1-4.0, 3) 4.1-6.0, 4) 6.1-8.0, 5) 8.1-10.0, 6) 10.1-12.0, 7) 12.1-14.0, 8) 14.1-16.0, 9) 16.1-18.0, 10) 18.1-20.0, 11) 20.1-22.0, 12) 22.1-24.0, 13) 24.1-26.0, 14) 26.1-28.0, 15) 28.1-30.0. All numbers are percentages of the total numbers of that species caught in a given year.

	SALINITY CATEGORY															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A. mitchilli																
1988	24	14		27	3	10	2		7	6		4		2		
1989	8	6	7	21	8	1		21	9	20						
F. similis																
1988	14	3	4	2	4	3	1	5	5	9		7	16	17	9	
1989	3	2	6	4	1	1	1		5	17	3	16	29	5	7	1
F. seminolis																
1988	85	3	8	1	2		1							1		
1989	84	5	3	2	5	1										
L. goodei																
1988	99			1												
1989	94	1		3	1	2										
G. affinis																
1988	94	2	2	1	1		1									
1989	51	15	13		18	1		2	1							
P. latipinna																
1988	89	2	6		2		1									
1989	71	16	2		8				2							
Menidia spp.																
1988	9	8	5	4	9	4	10	1	8	9	2	7	7	6	10	
1989	6	1	7	2	4	3		5	3	12	3	7	11	25	7	3
C. undecimalis																
1988	49	41		5	3				3							
1989	33	10	14	1	30	3		3	6							1
L. rhomboides																
1988	18	2		1	13	3	6	1	2	9	1	4	5	15	19	
1989	2								1	7	18	6	34	20	9	2
B. chrysoura																
1988	5	5	3	5	4	16	11	13	3	6		1	27		1	
1989	2			7	1	2				30		4	33	1	20	
C. arenarius																
1988	29	11	9		16	2	2	23	2	4						
1989	22	10	31	5	12	1		4	10	2			2			

Table 4. Continued.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<u>C</u>. <u>nebulosus</u>																
1988	5	4	1	1	6	14	15	11	18	8		5		3	9	
1989	4	2		7	1	2		2	2	39		9	30		1	
<u>L</u>. <u>xanthurus</u>																
1988	11	19	1	6	11	17	7		5	3	3	11	1	2	2	
1989	4	12	1		5	4		6	3	4	3	50	1	2	3	
<u>S</u>. <u>ocellatus</u>																
1988	19	16	13	11	13	9	5		7	5		2				
1989	24	30	2		20	4		5	13		1	1				
<u>M</u>. <u>cephalus</u>																
1988	10	21	2	2	3	12	8		19	9	4	3	2	3	2	
1989	14	8	40	4	8	3		2	2	13	4	3	1		1	
<u>M</u>. <u>gulosus</u>																
1988	62	4	3	1	5		2	1	1	8		2	2	9	1	
1989	63	3	12	3	4	3	2	2		3		2	2	1		
<u>T</u>. <u>maculatus</u>																
1988	93	2	1	1	1		1			1						
1989	81	4	5	1	2	2		1	1	2						

Table 5. Distribution of selected fish species among six sampling stations in the Little Manatee River, 1988 and 1989. Station locations described in text. Numbers are percentages of the total number of that species caught in a given year.

	STATION 1	2	3	4	5	6
A. mitchilli						
1988	6	19	25	33	10	8
1989	18	13	28	31	5	4
F. similis						
1988	51	24	22		3	
1989	66	20	14			
F. seminolis						
1988	1		1	11	58	30
1989			1	34	28	38
L. goodei						
1988				1	22	77
1989				1	18	80
G. affinis						
1988				27	51	22
1989			39	21	25	14
P. latipinna						
1988			2	19	65	13
1989		4	56	30	6	4
Menidia spp.						
1988	36	27	19	16	1	
1989	49	24	15	11	1	
C. undecimalis						
1988		26	26	36	10	3
1989	1	3	64	31	1	
L. rhomboides						
1988	70	8	4	18	1	
1989	90	6	2	2		
B. chrysoura						
1988	68	9	9	13	1	
1989	69	21	7	3		
C. arenarius						
1988	26	17	41	15		
1989	3	14	50	33		

Table 5. Continued.

		STATION					
		1	2	3	4	5	6
C. nebulosus							
	1988	63	13	11	12	1	
	1989	53	28	15	2	1	
L. xanthurus							
	1988	20	35	35	9	2	
	1989	58	11	16	14	1	
S. ocellatus							
	1988	8	25	55	11	1	
	1989	2	18	47	30	3	
M. cephalus							
	1988	14	33	50	3		
	1989	11	13	29	47		
M. gulosus							
	1988	5	19	14	24	32	6
	1989	3	10	10	40	15	22
T. maculatus							
	1988		1	5	15	36	44
	1989	1	1	4	32	31	30

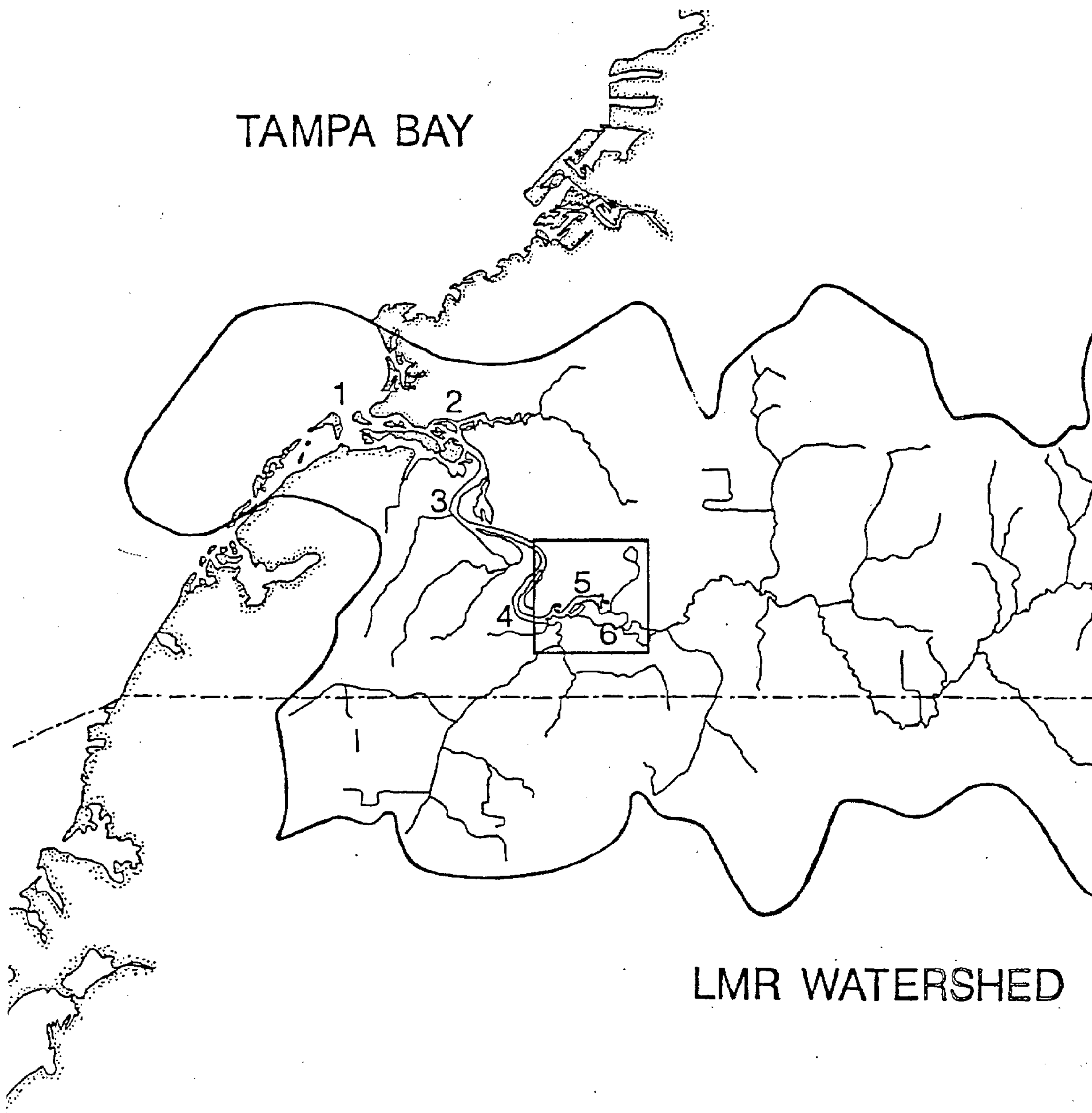
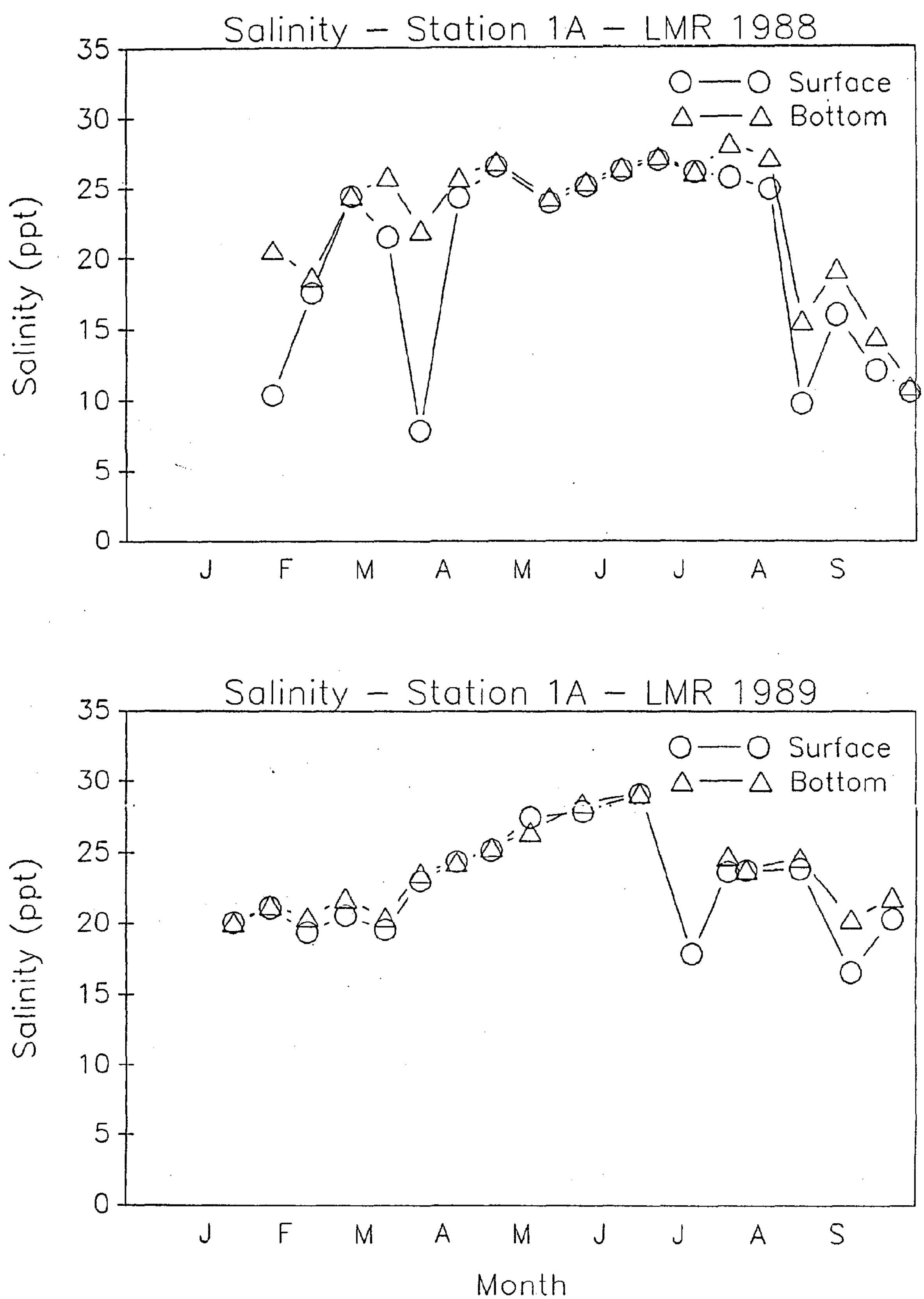


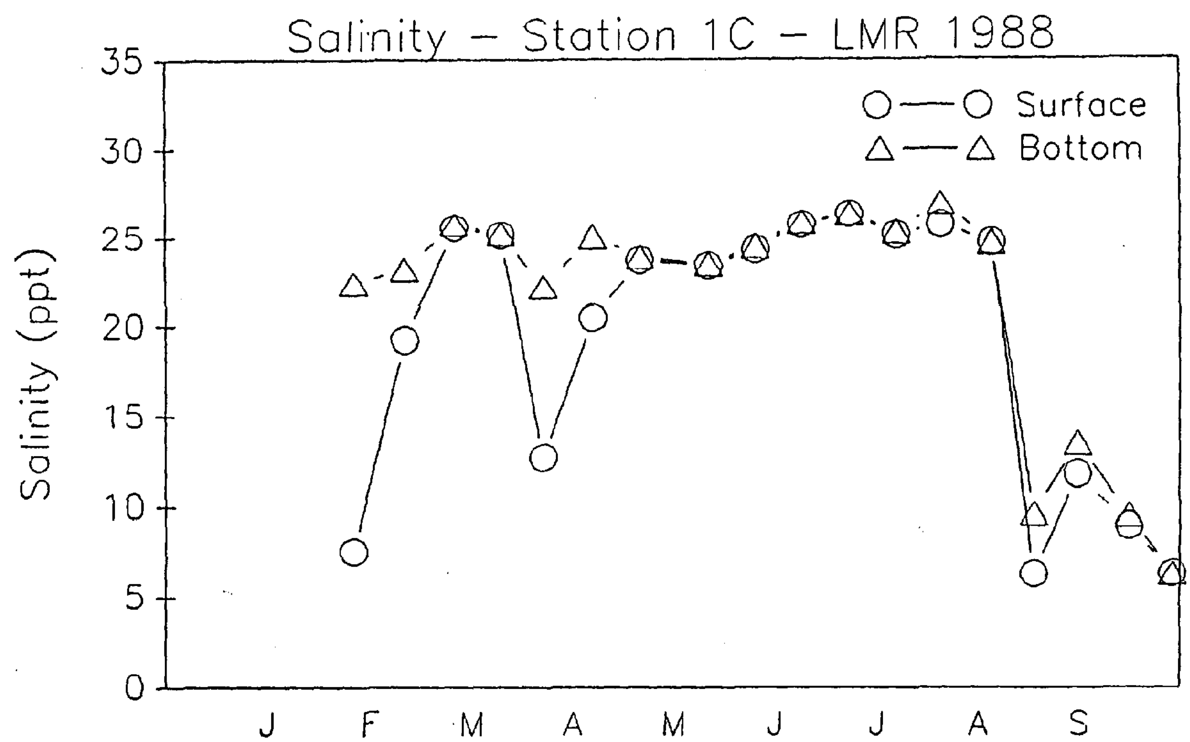
FIGURE 1: LITTLE MANATEE RIVER WATERSHED

FIGURE 2



Salinity – Station 1A – LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Salinity – Station 1A – LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 3


Salinity - Station 1C - LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S

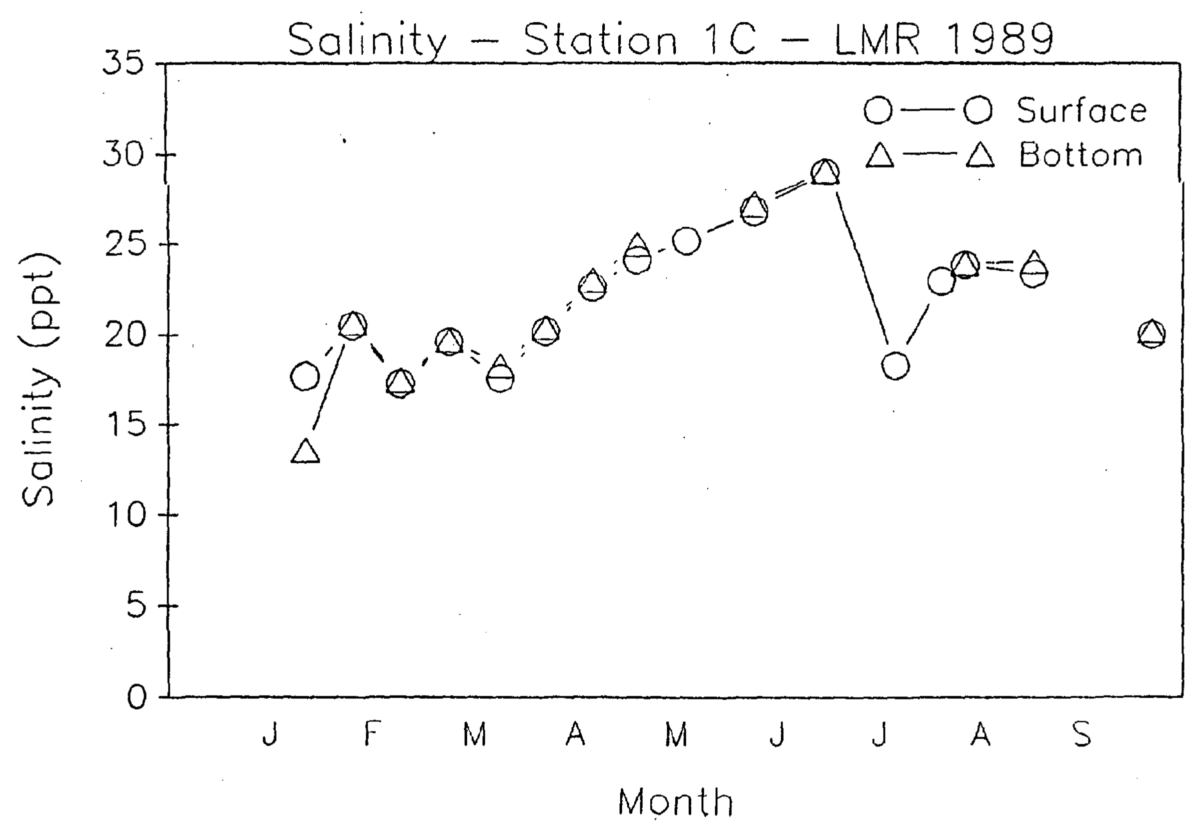
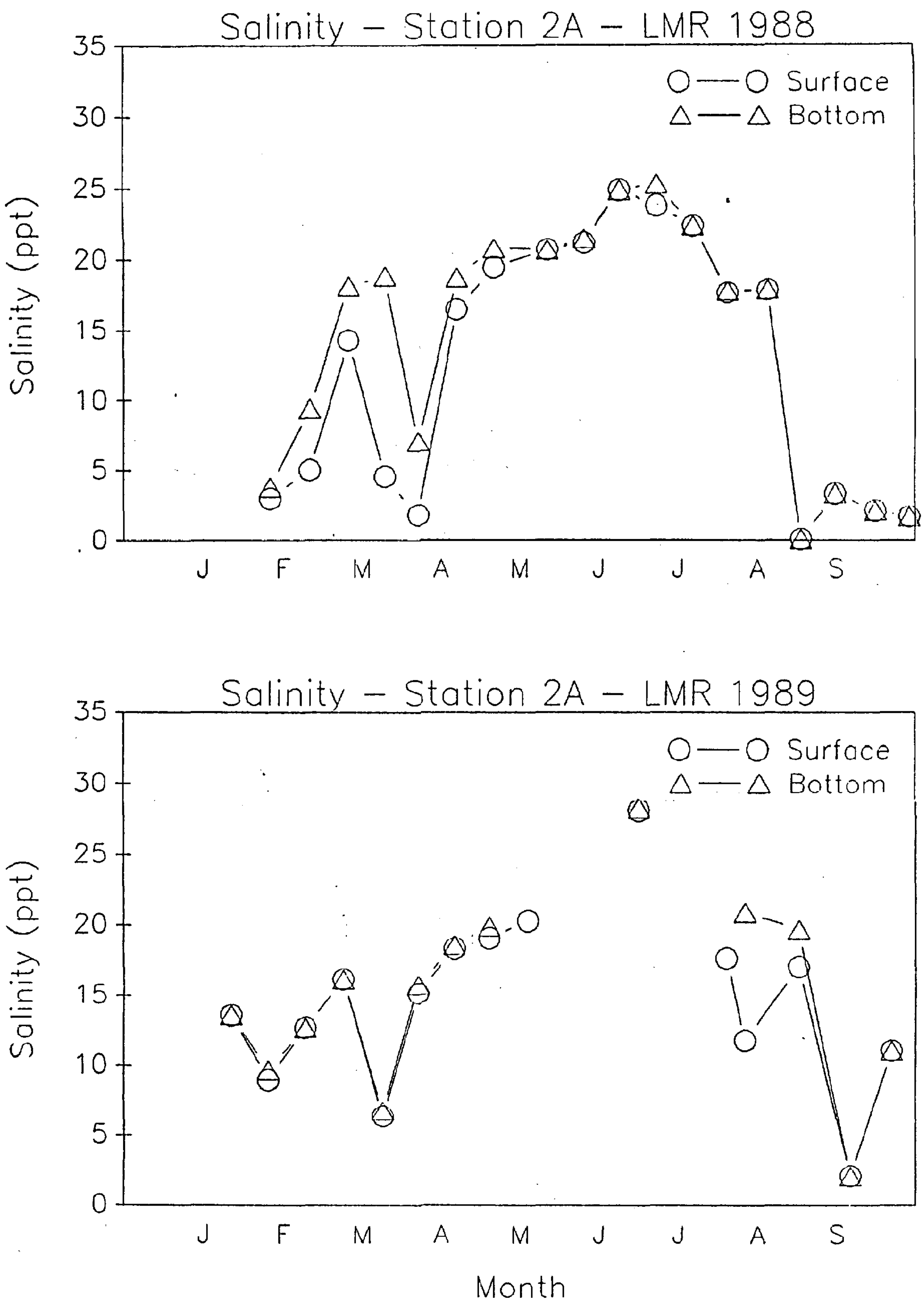

Salinity - Station 1C - LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 4



Salinity – Station 2A – LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Salinity – Station 2A – LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 5

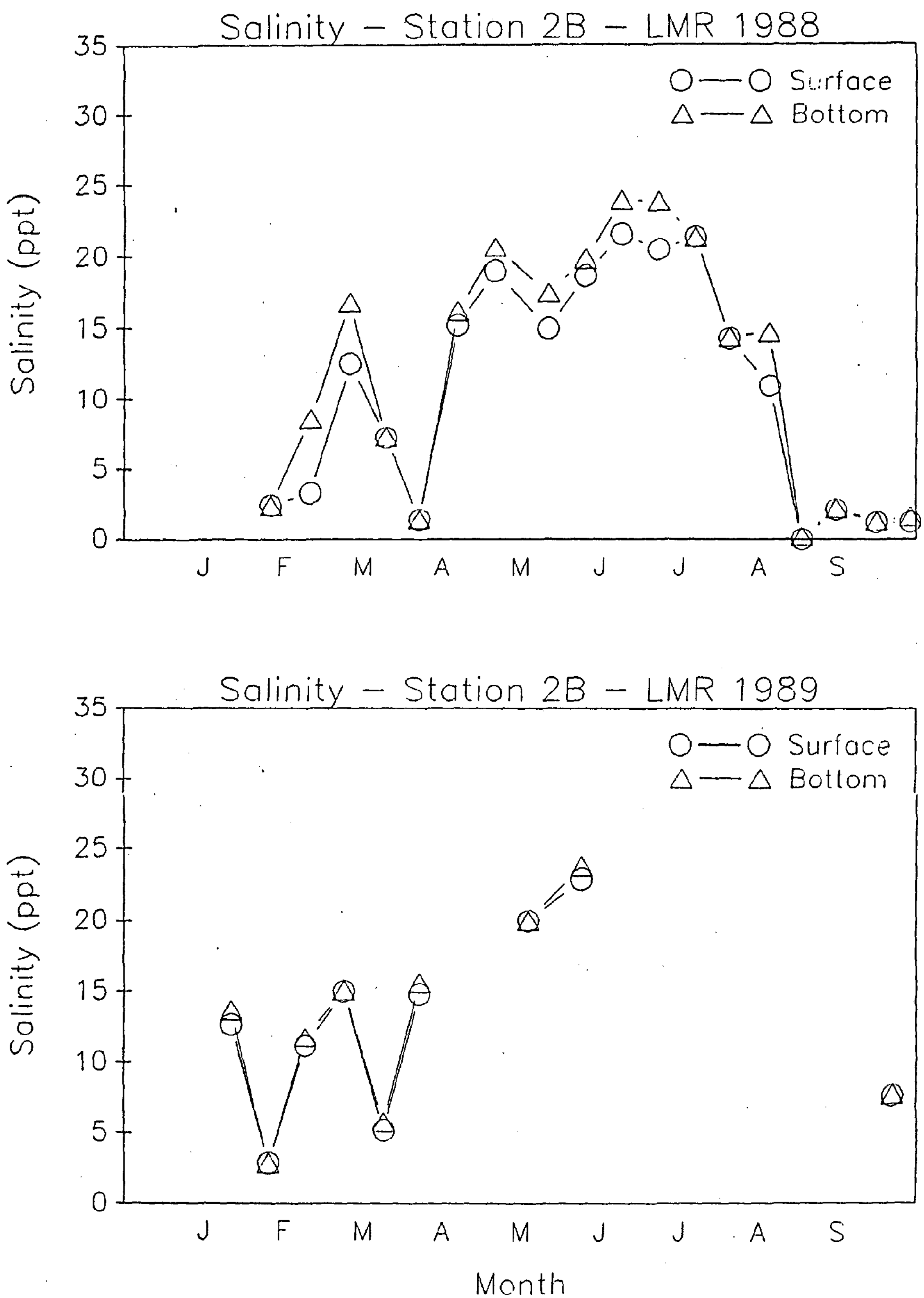
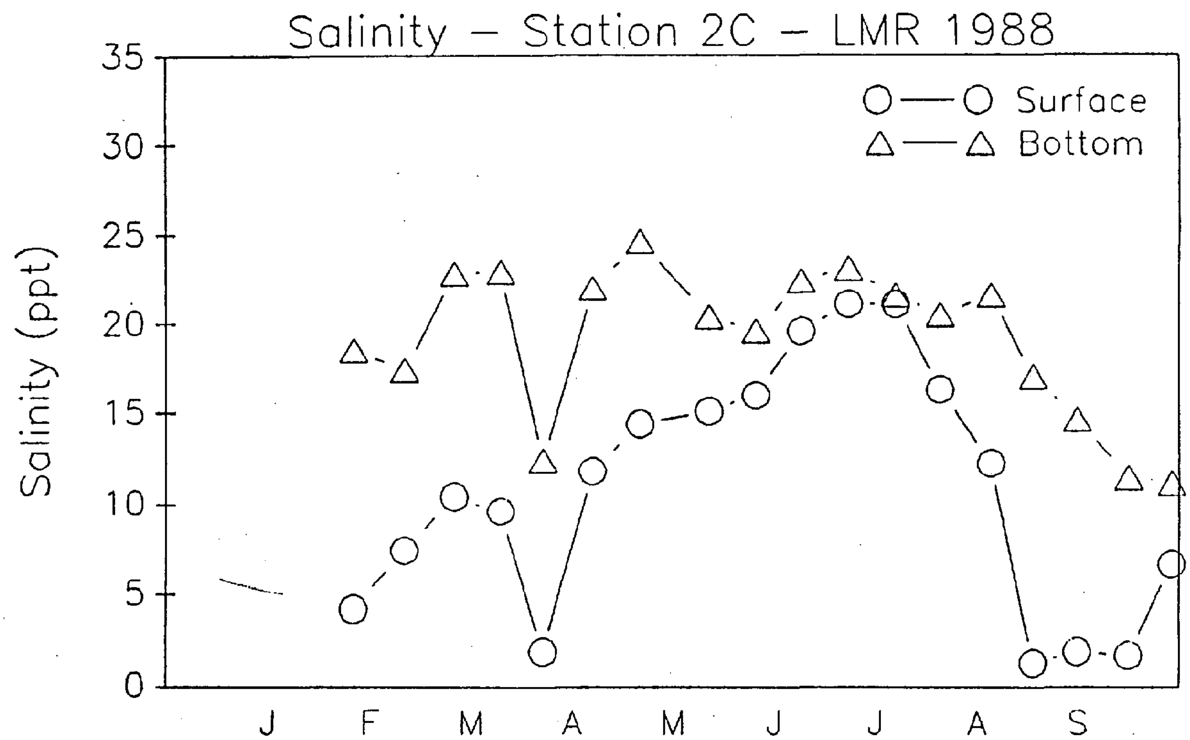
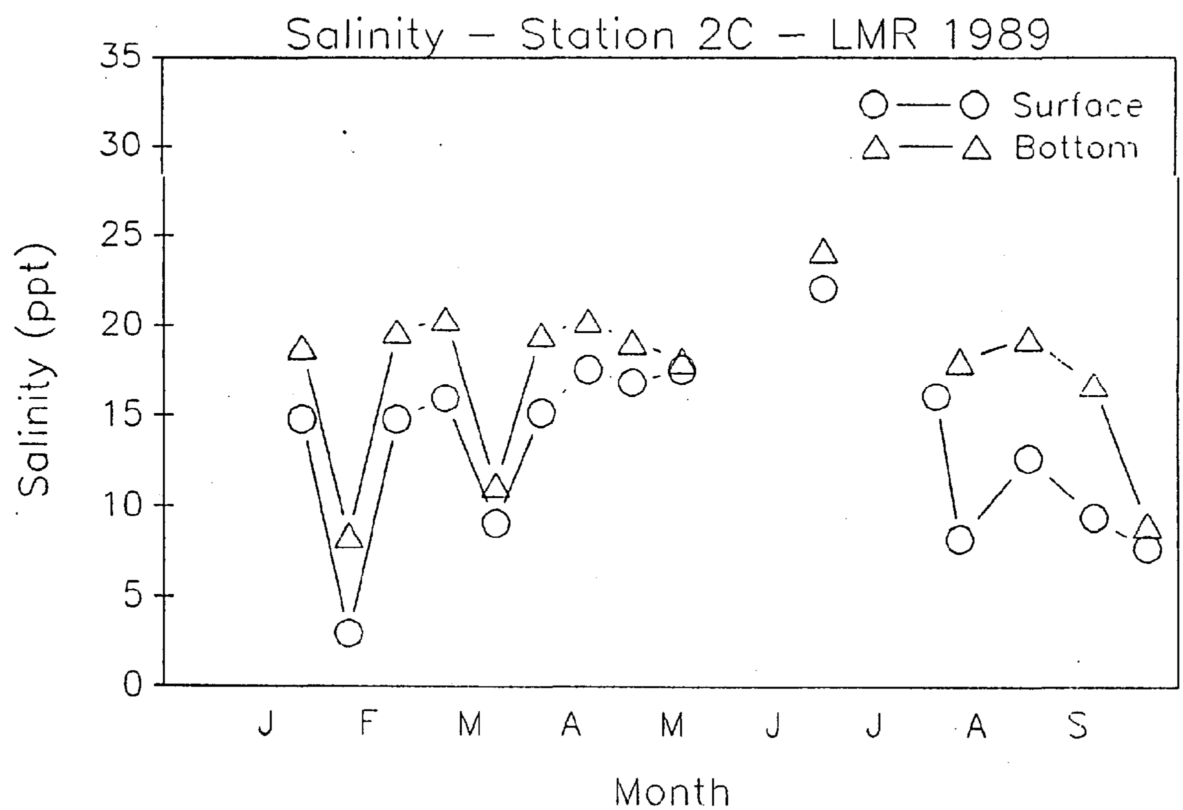

Salinity – Station 2B – LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Salinity – Station 2B – LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 6

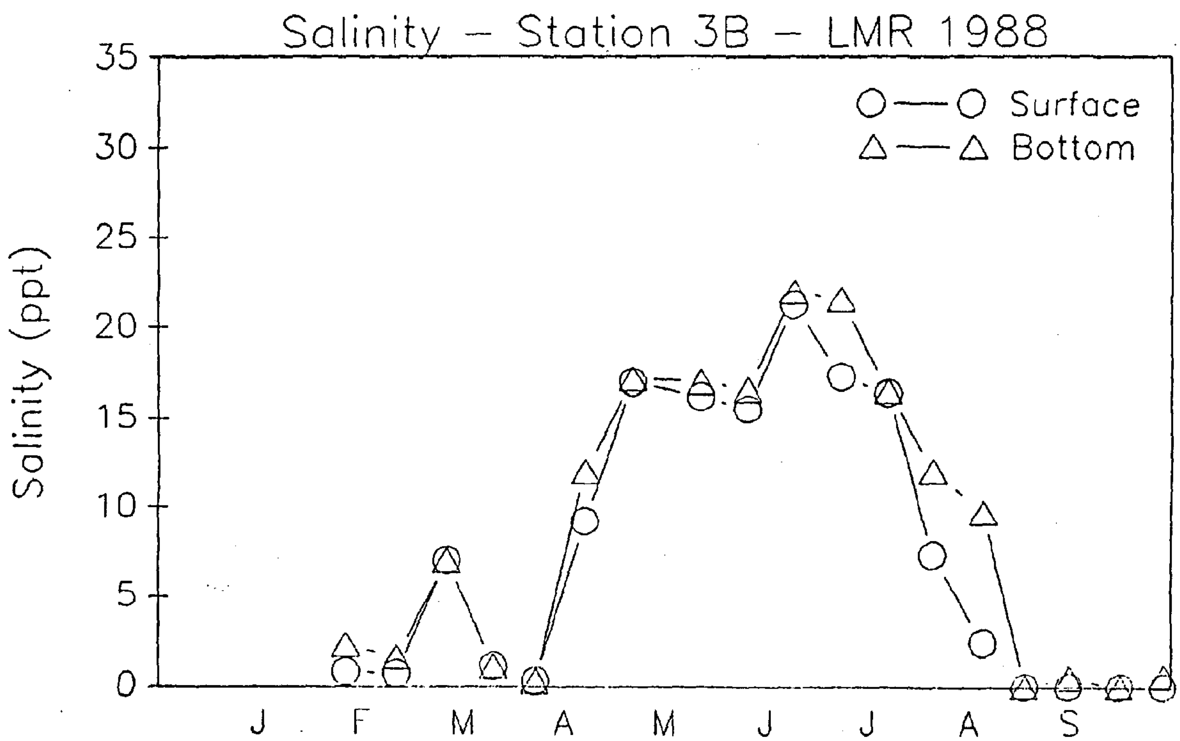


Salinity – Station 2C – LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S

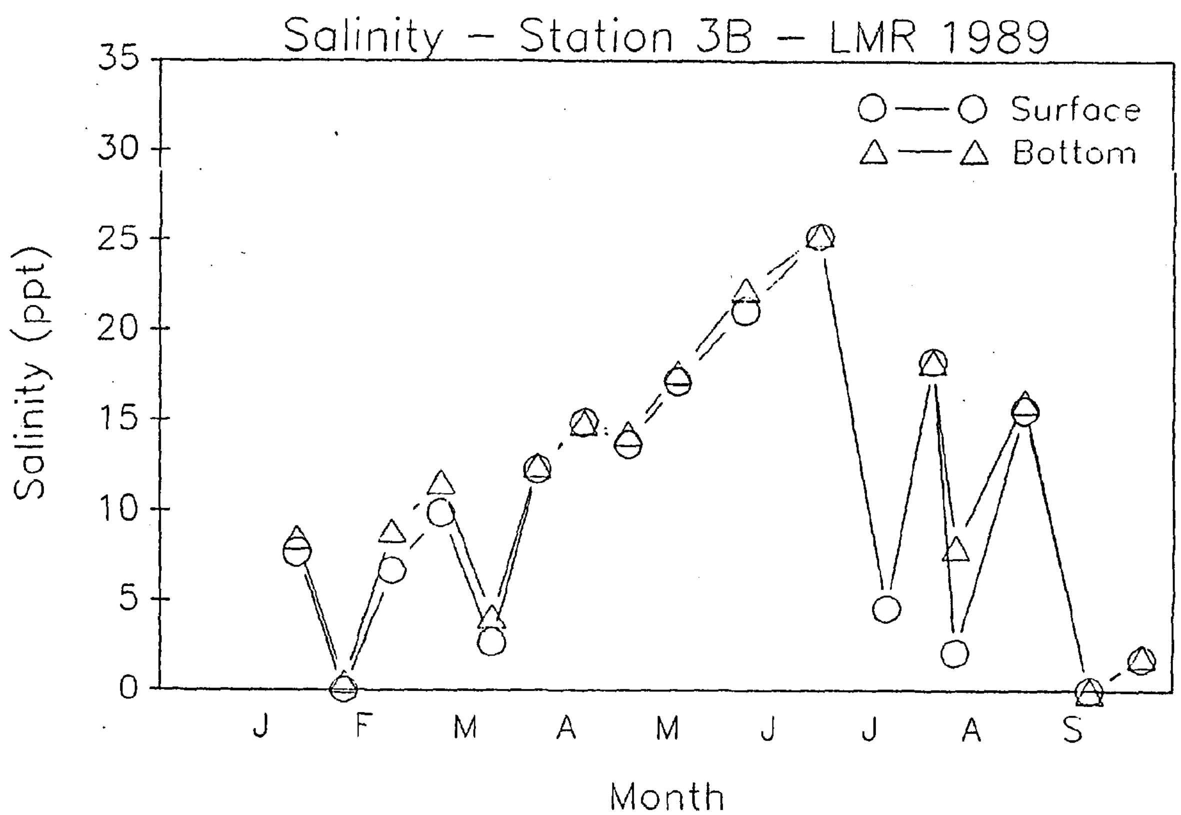


Salinity – Station 2C – LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 7

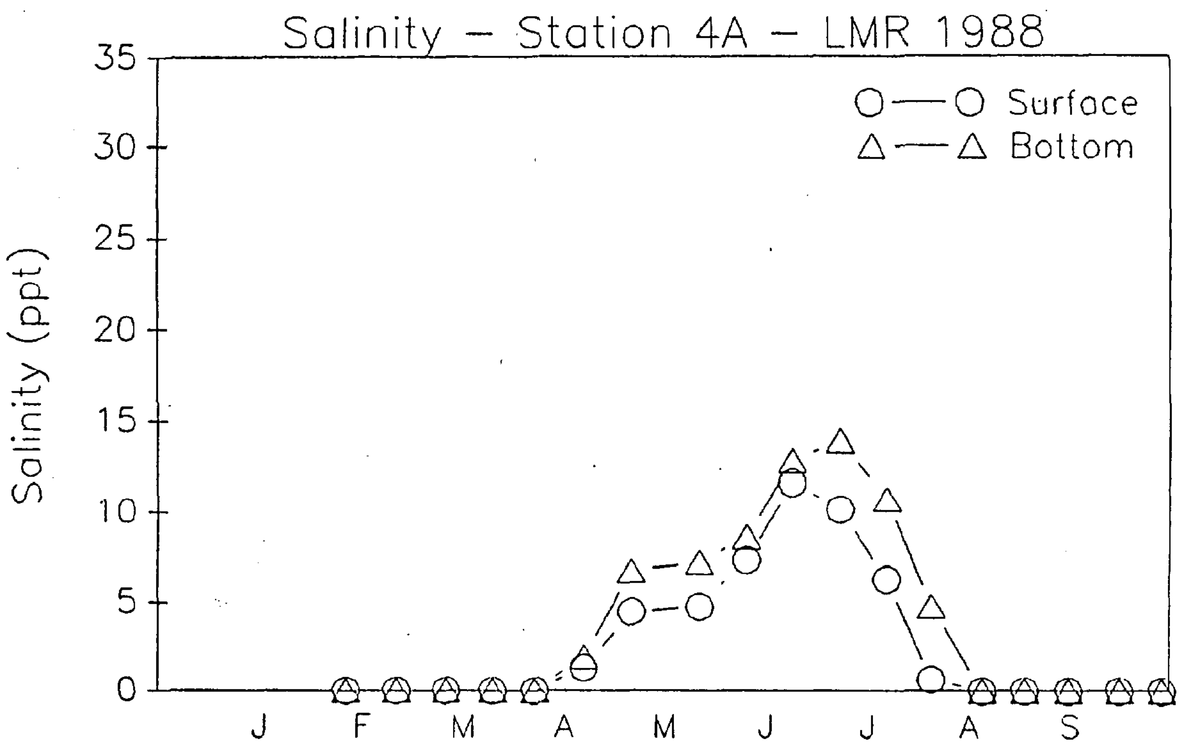


Salinity – Station 3B – LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S



Salinity – Station 3B – LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 8


Salinity - Station 4A - LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S

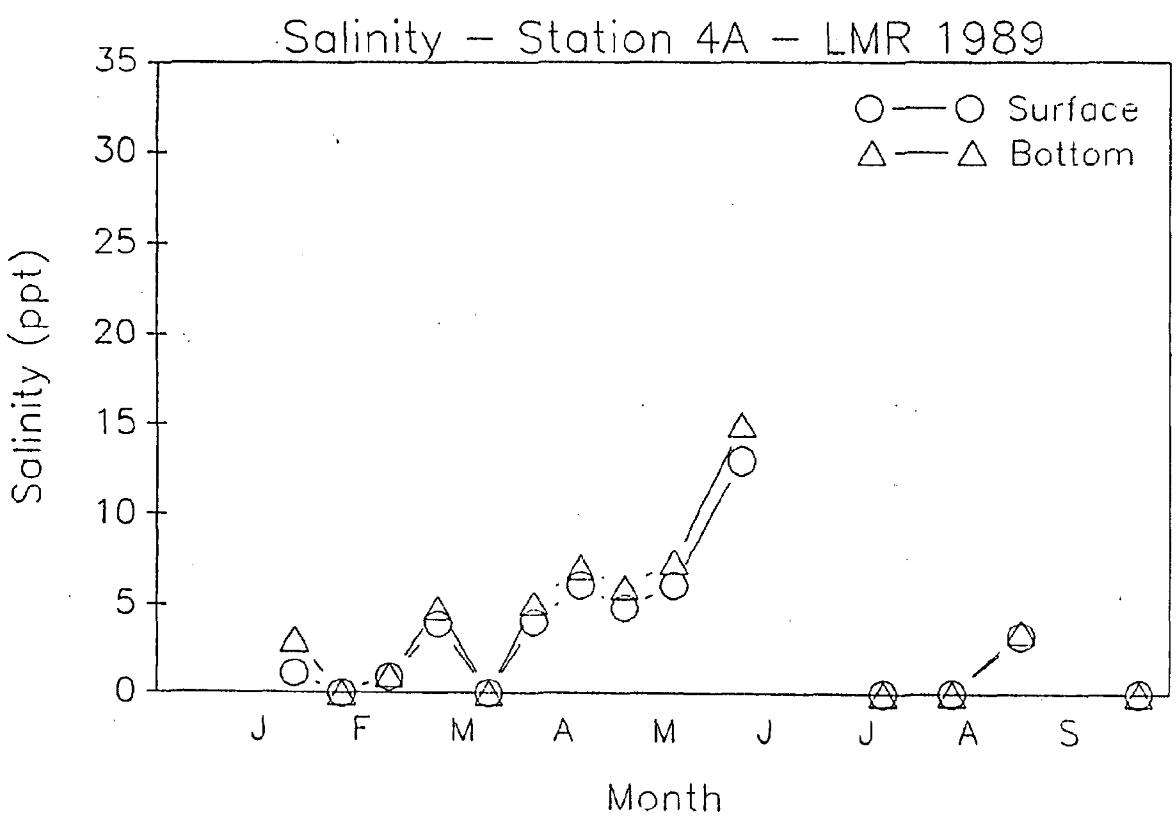
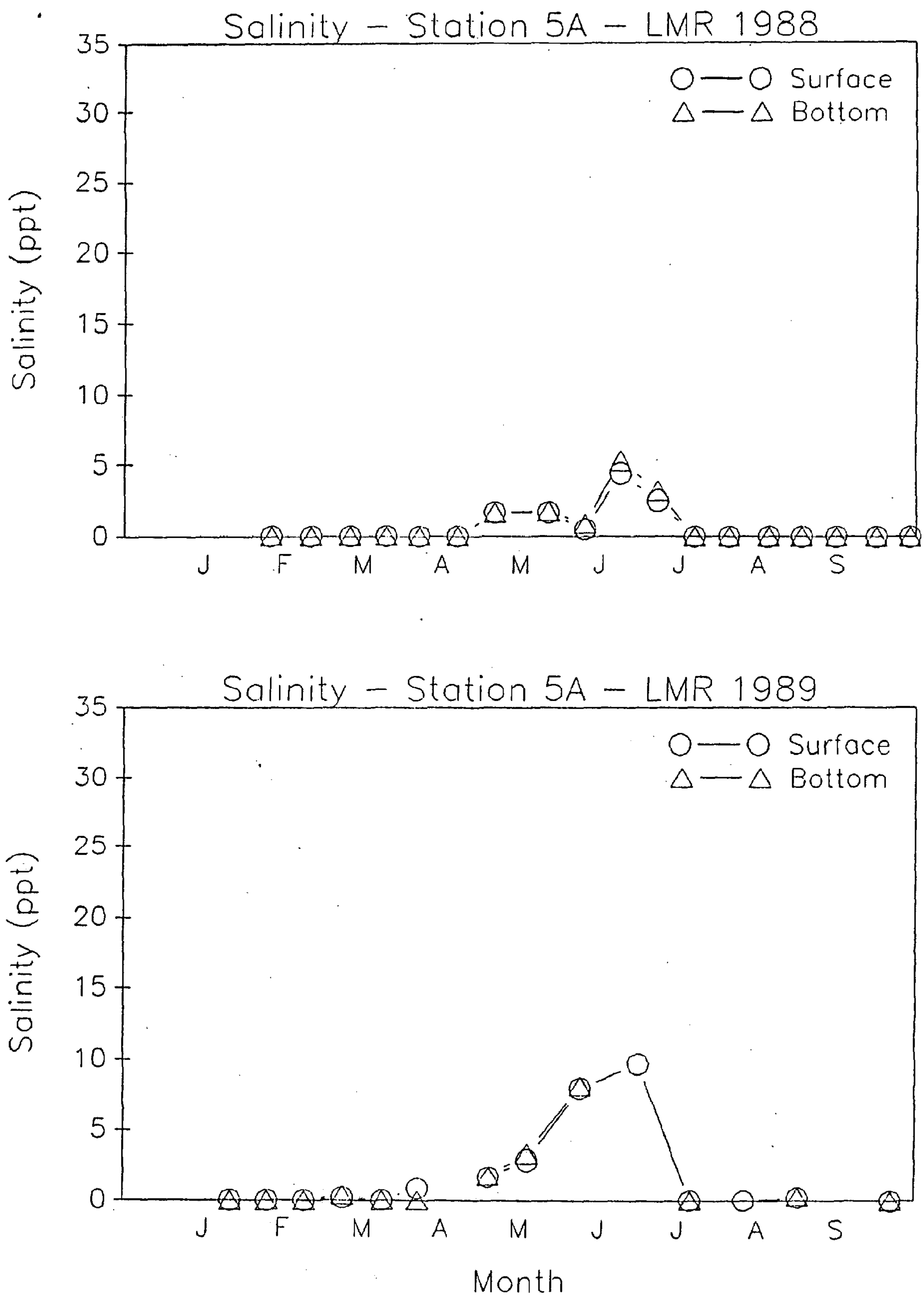
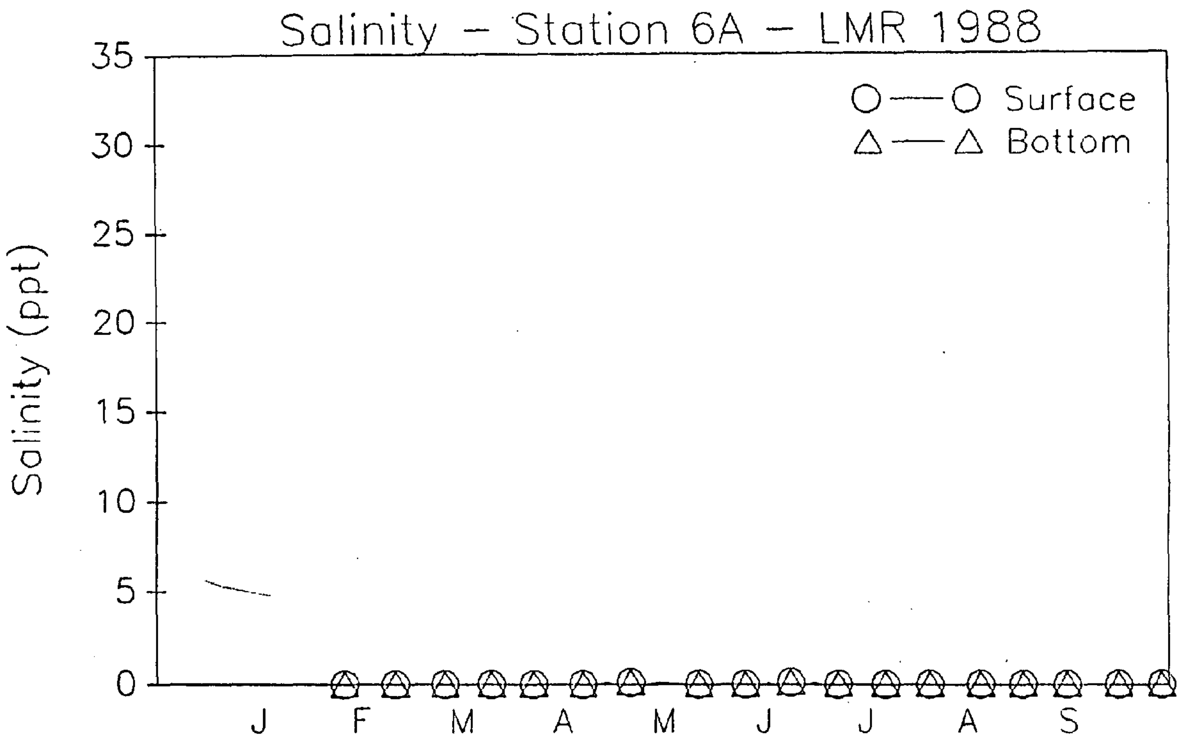

Salinity - Station 4A - LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 9

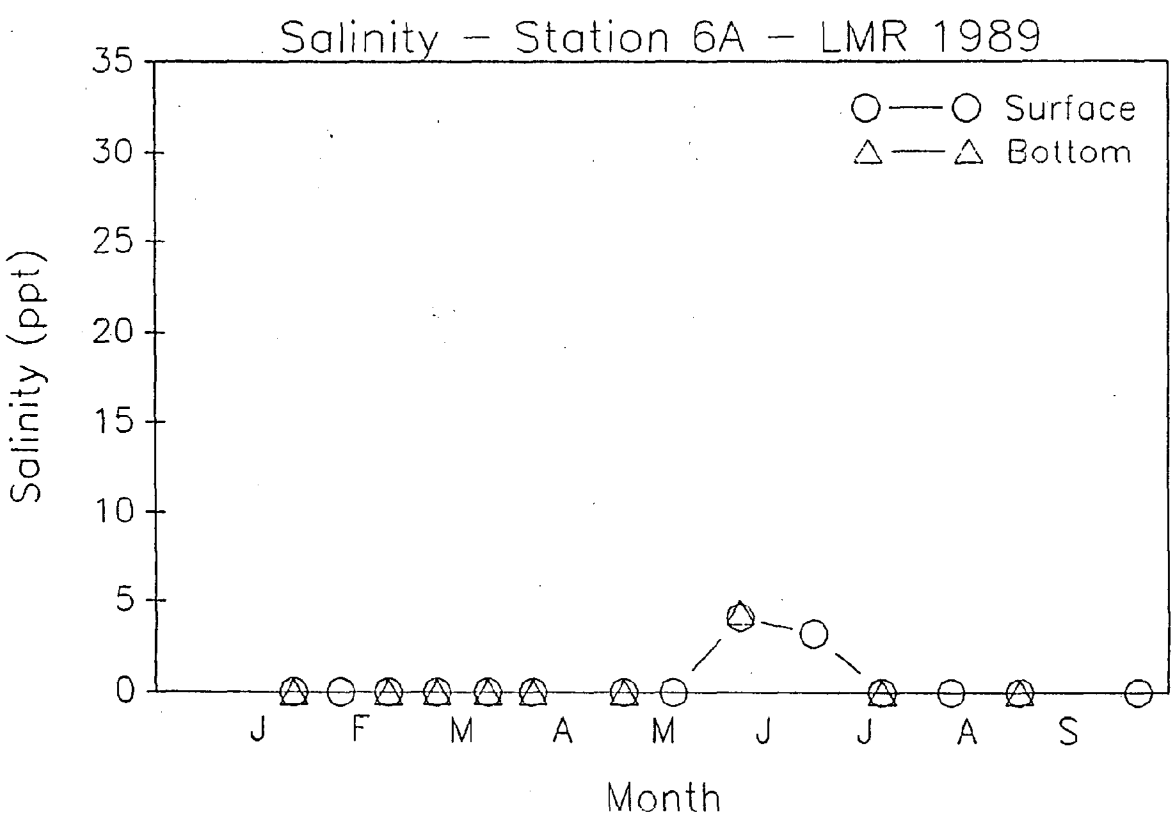


Salinity – Station 5A – LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Salinity – Station 5A – LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 10



Salinity - Station 6A - LMR 1988
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S



Salinity - Station 6A - LMR 1989
Surface
Bottom
Salinity (ppt)
35
30
25
20
15
10
5
0
J
F
M
A
M
J
J
A
S
Month

FIGURE 11

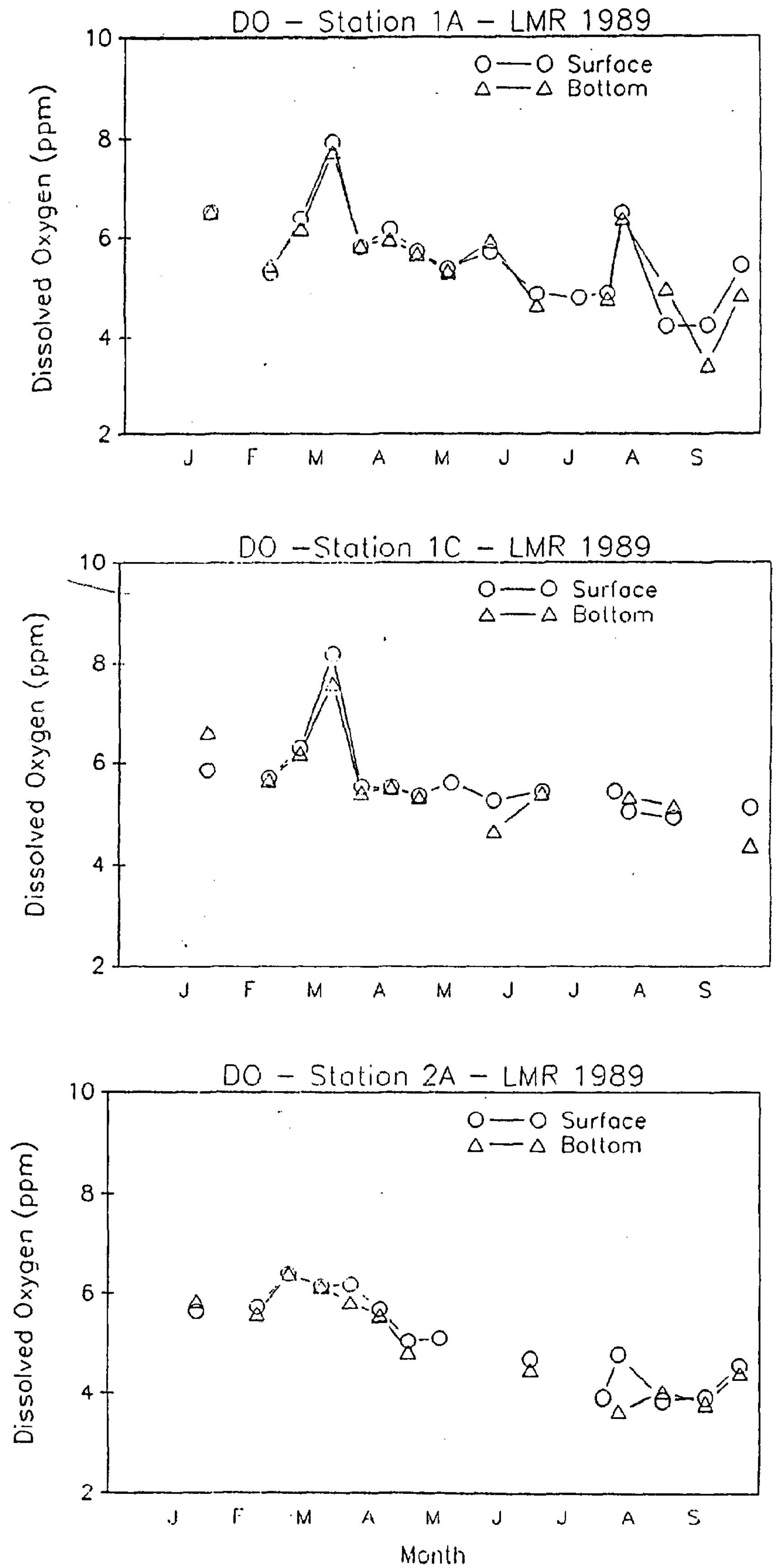
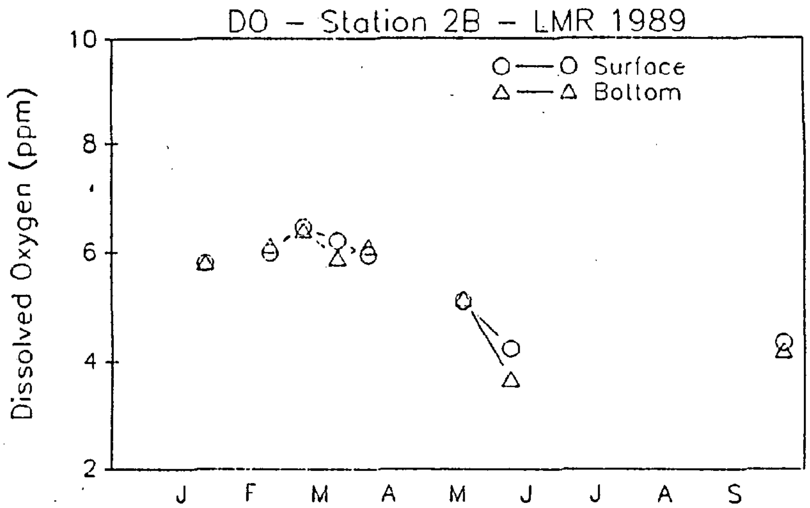
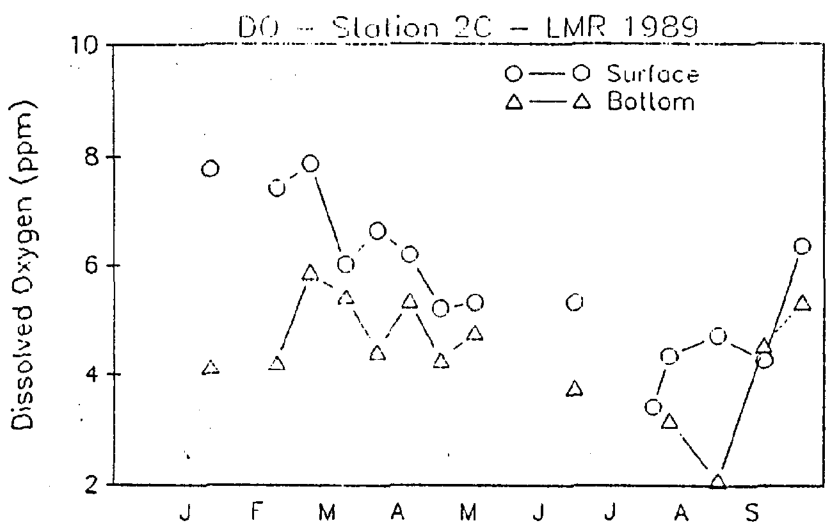

DO – Station 1A – LMR 1989
O—O Surface
△—△ Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S
DO –Station 1C – LMR 1989
O—O Surface
△—△ Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S
DO – Station 2A – LMR 1989
O—O Surface
△—△ Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S
Month

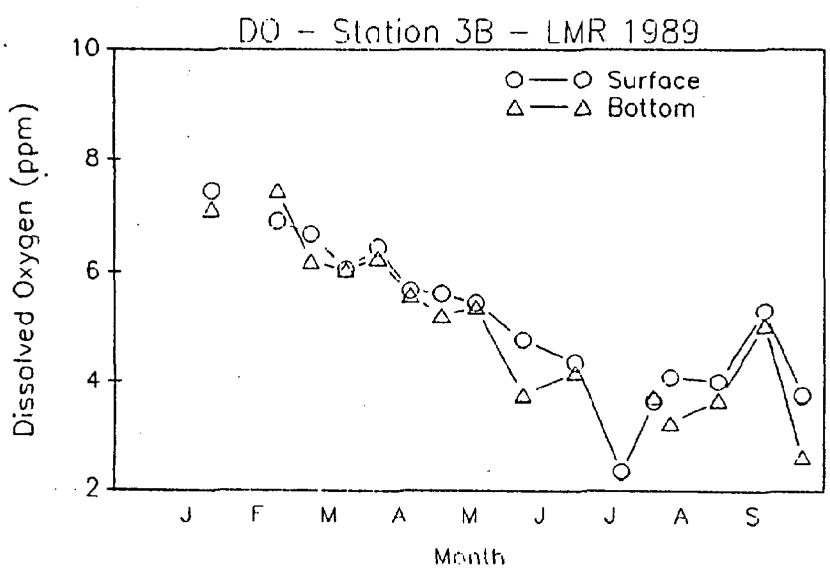
FIGURE 12



DO – Station 2B – LMR 1989
Surface
Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S

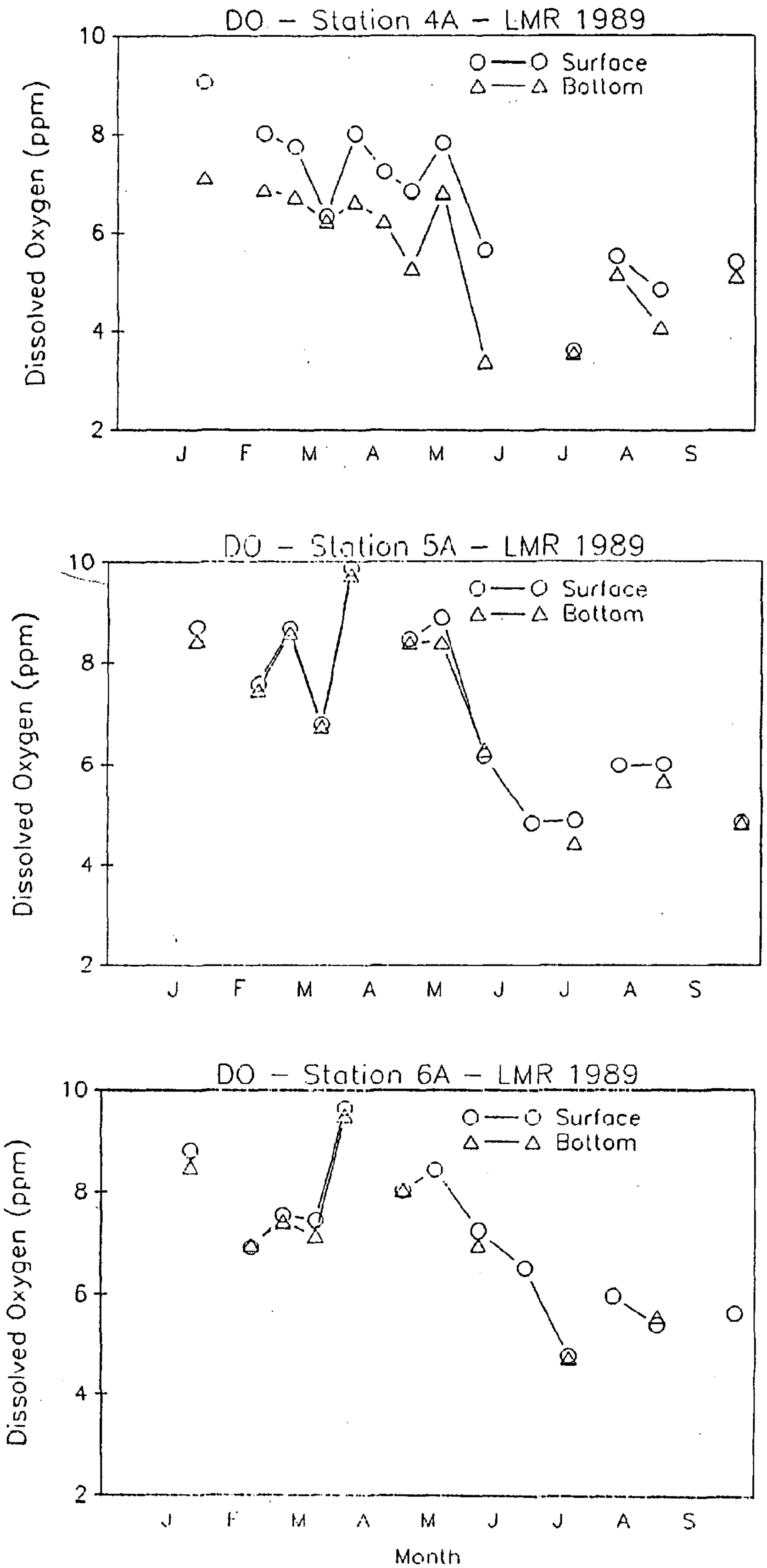


DO – Station 2C – LMR 1989
Surface
Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S



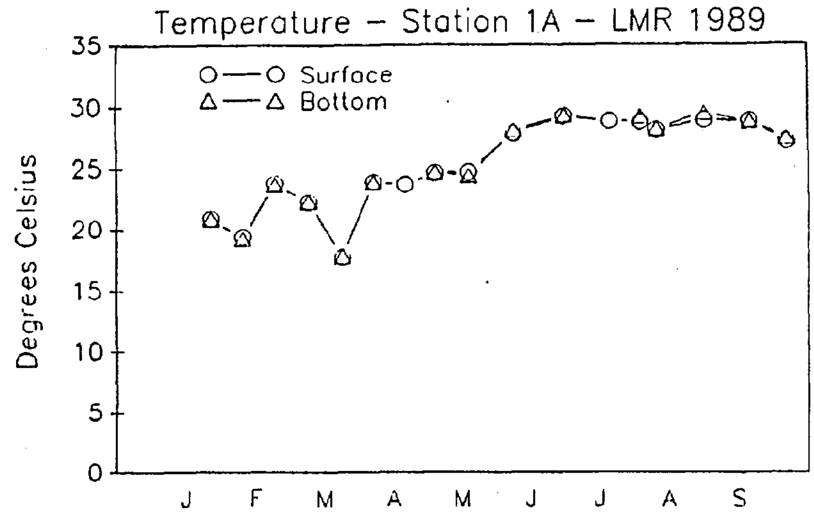
DO – Station 3B – LMR 1989
Surface
Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S
Month

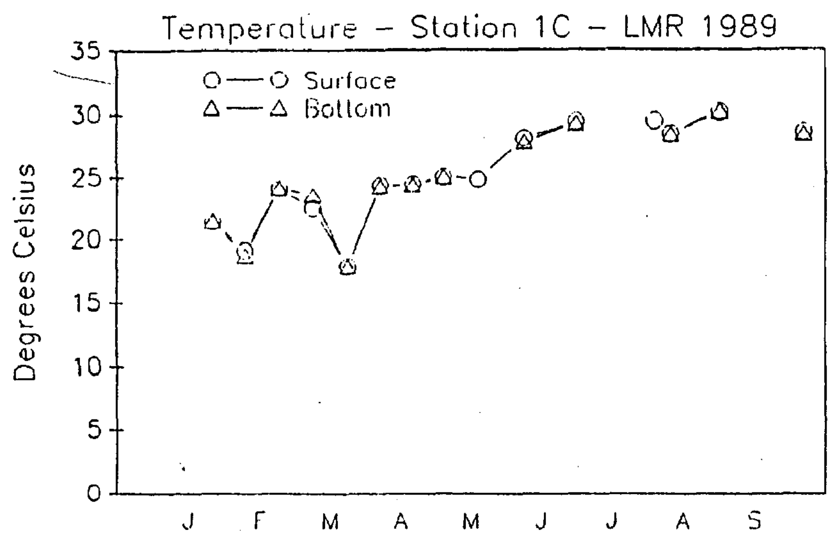
FIGURE 13



DO – Station 4A – LMR 1989
Surface
Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S
DO – Station 5A – LMR 1989
Surface
Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S
DO – Station 6A – LMR 1989
Surface
Bottom
Dissolved Oxygen (ppm)
10
8
6
4
2
J F M A M J J A S
Month

FIGURE 14


Temperature - Station 1A - LMR 1989
Surface
Bottom
Degrees Celsius
0
5
10
15
20
25
30
35
J F M A M J J A S


Temperature - Station 1C - LMR 1989
Surface
Bottom
Degrees Celsius
0
5
10
15
20
25
30
35
J F M A M J J A S

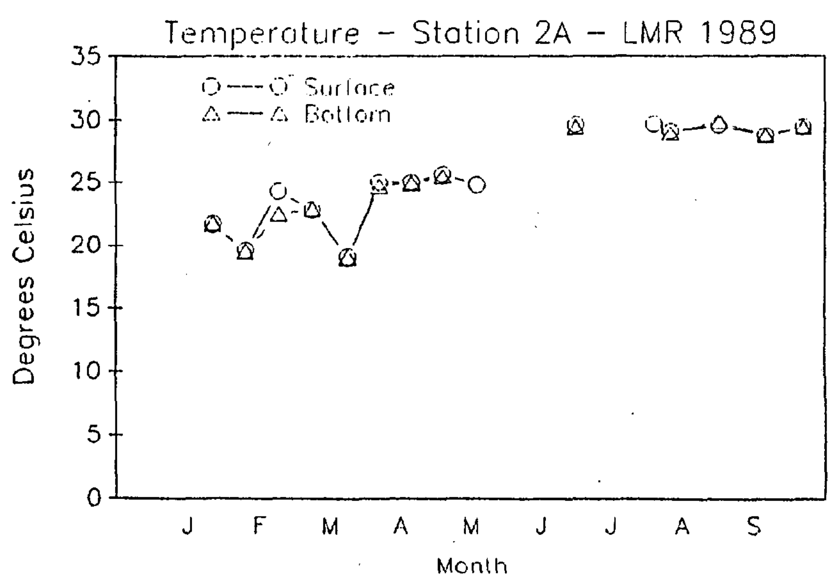

Temperature - Station 2A - LMR 1989
Surface
Bottom
Degrees Celsius
0
5
10
15
20
25
30
35
J F M A M J J A S
Month

FIGURE 15

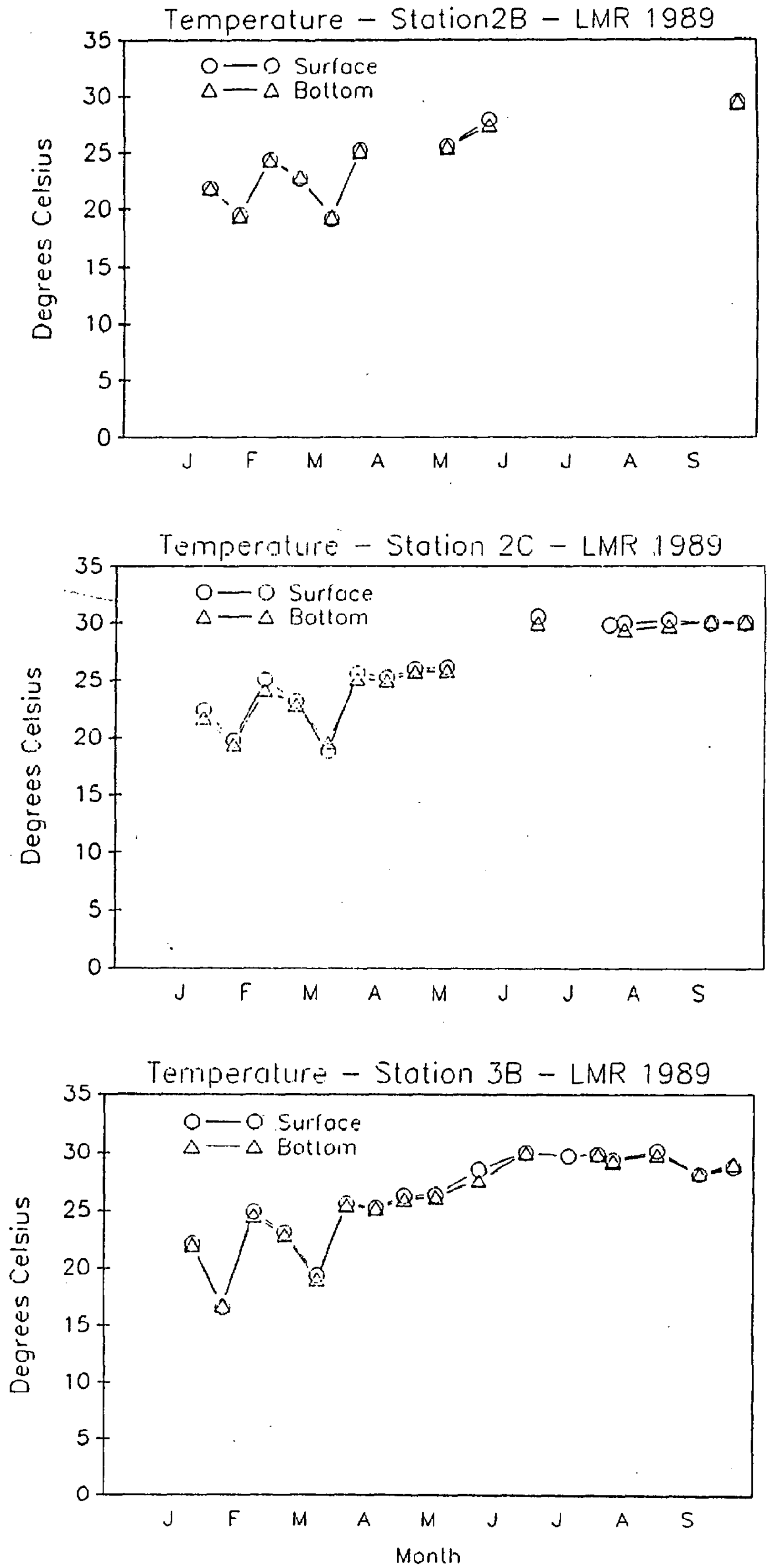

Temperature - Station2B - LMR 1989
Surface
Bottom
Degrees Celsius
35
30
25
20
15
10
5
0
J F M A M J J A S
Temperature - Station 2C - LMR 1989
Surface
Bottom
Degrees Celsius
35
30
25
20
15
10
5
0
J F M A M J J A S
Temperature - Station 3B - LMR 1989
Surface
Bottom
Degrees Celsius
35
30
25
20
15
10
5
0
J F M A M J J A S
Month

FIGURE 16

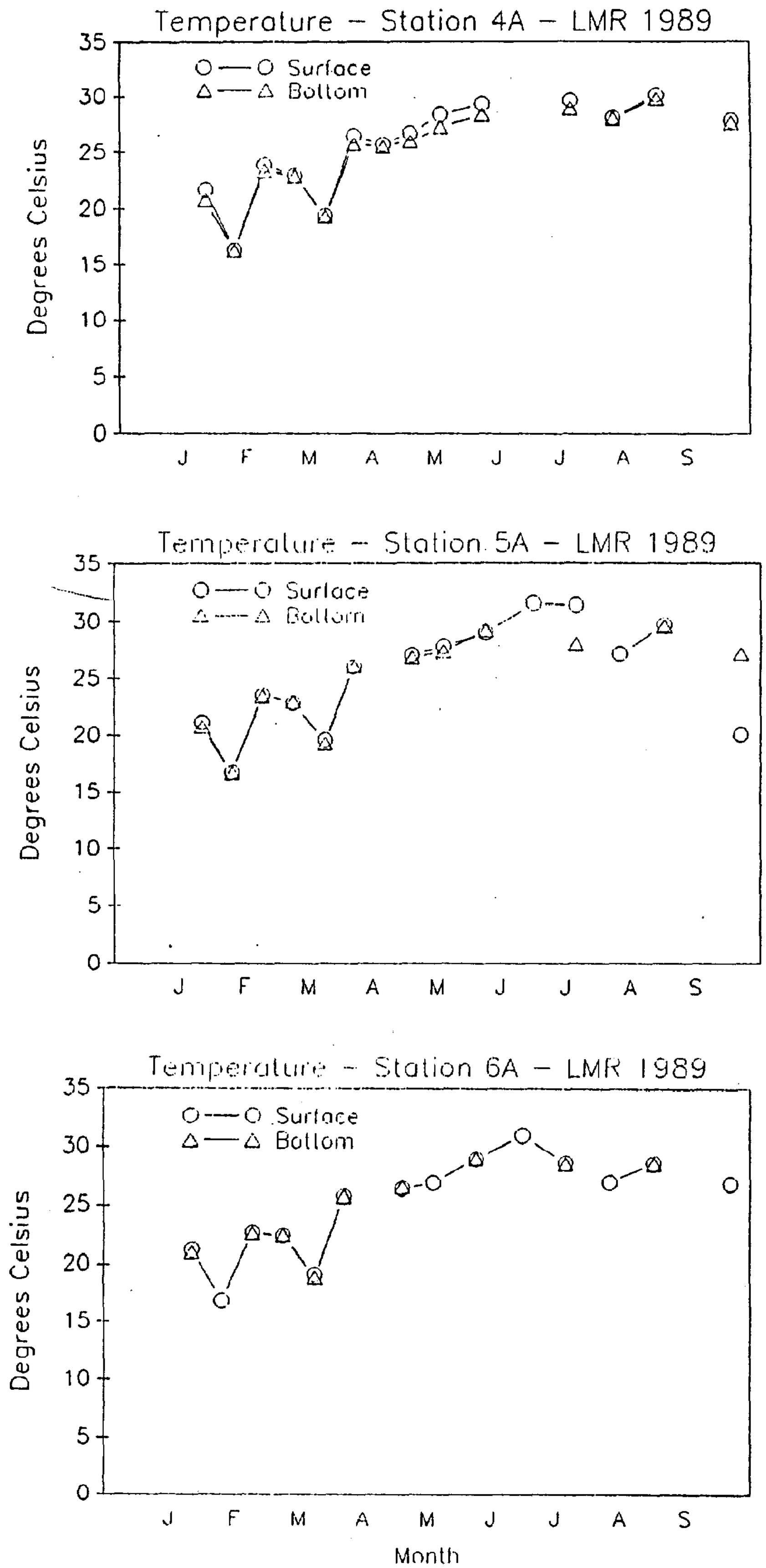

Temperature - Station 4A - LMR 1989
Surface
Bottom
Degrees Celsius
35
30
25
20
15
10
5
0
J F M A M J J A S
Temperature - Station 5A - LMR 1989
Surface
Bottom
Degrees Celsius
35
30
25
20
15
10
5
0
J F M A M J J A S
Temperature - Station 6A - LMR 1989
Surface
Bottom
Degrees Celsius
35
30
25
20
15
10
5
0
J F M A M J J A S
Month

FIGURE 20

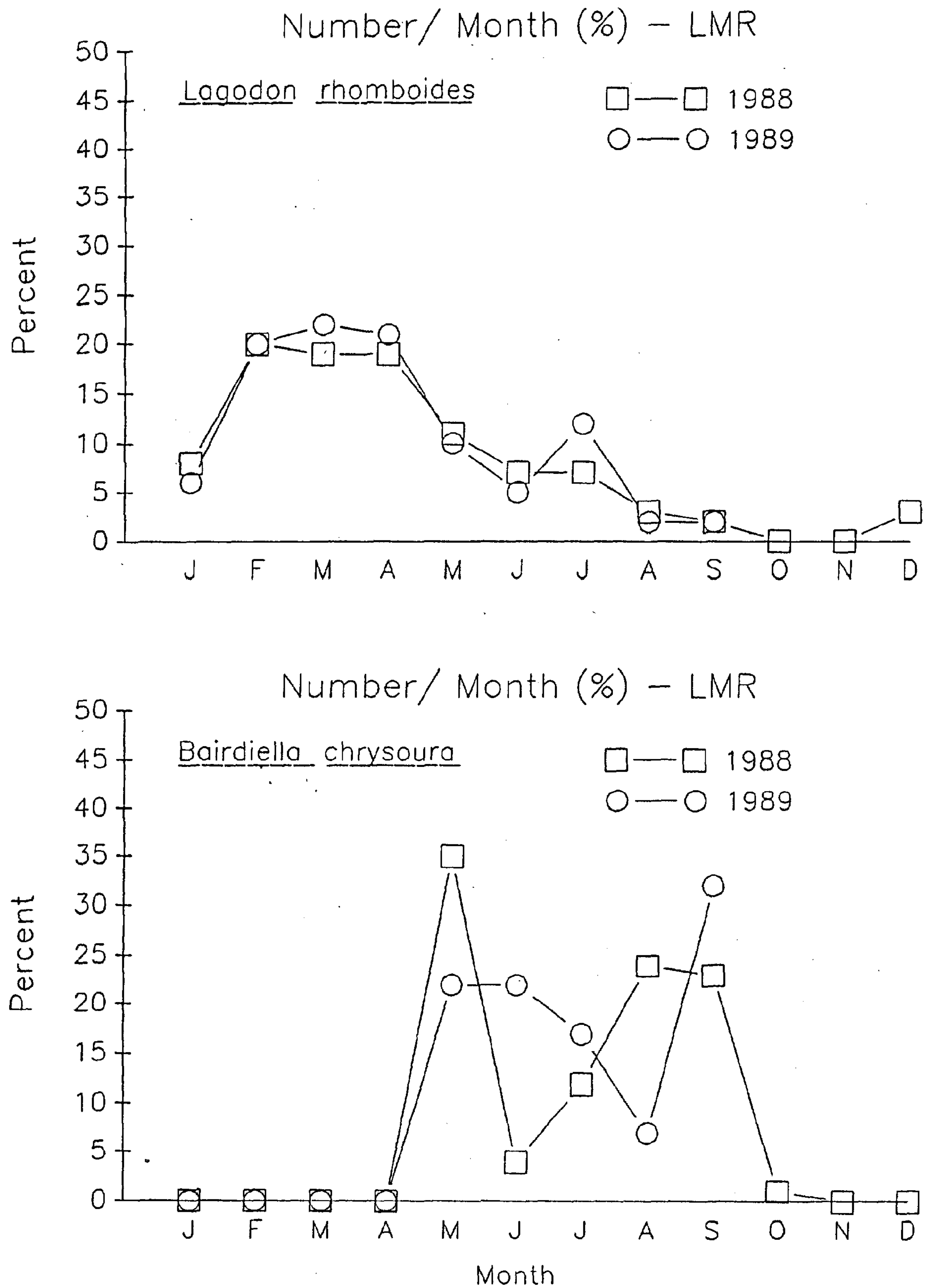
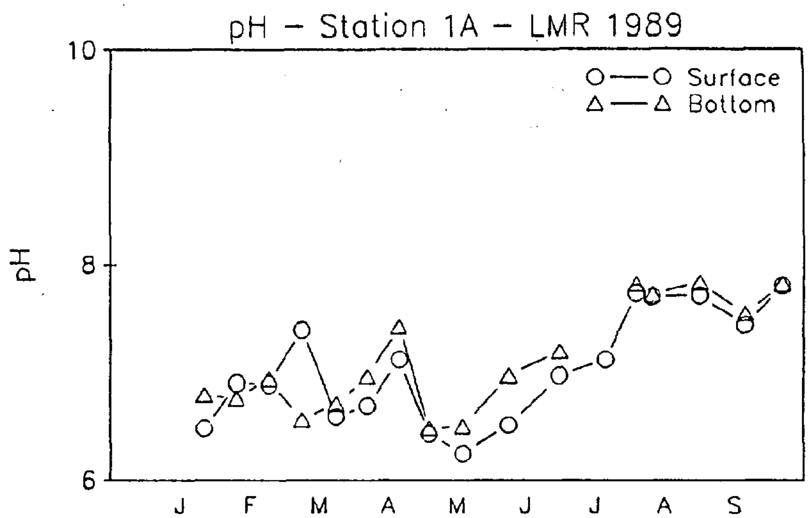
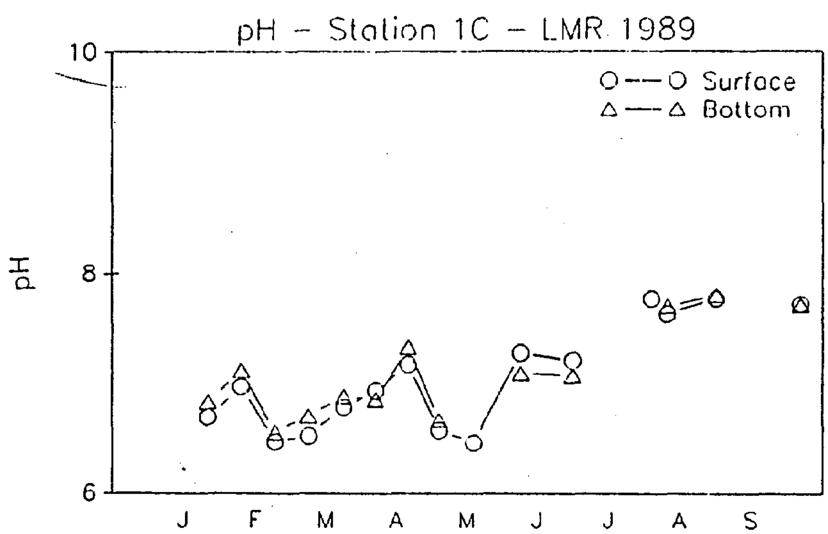

Number/ Month (%) - LMR
Lagodon rhomboides
1988
1989
Percent
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
Number/ Month (%) - LMR
Bairdiella chrysoura
1988
1989
Percent
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
Month

FIGURE 17


pH - Station 1A - LMR 1989
10
8
6
pH
Surface
Bottom
J F M A M J J A S


pH - Station 1C - LMR 1989
10
8
6
pH
Surface
Bottom
J F M A M J J A S

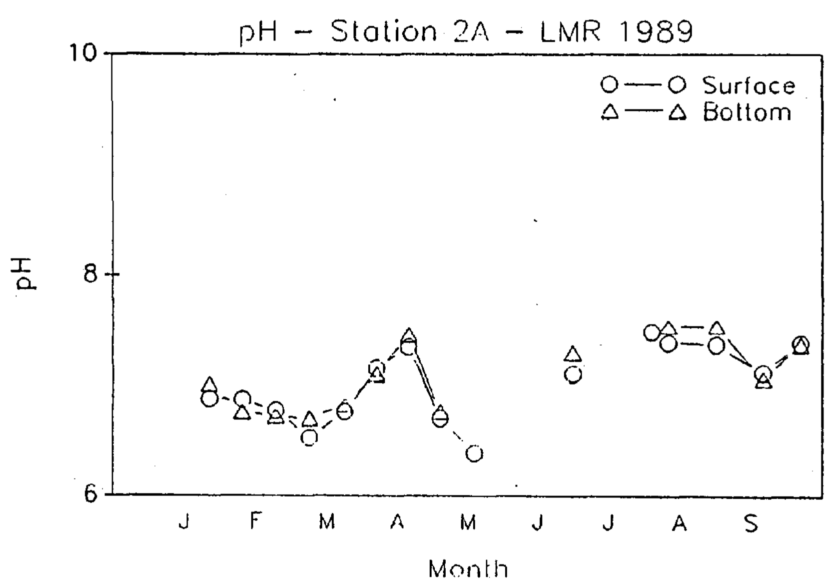
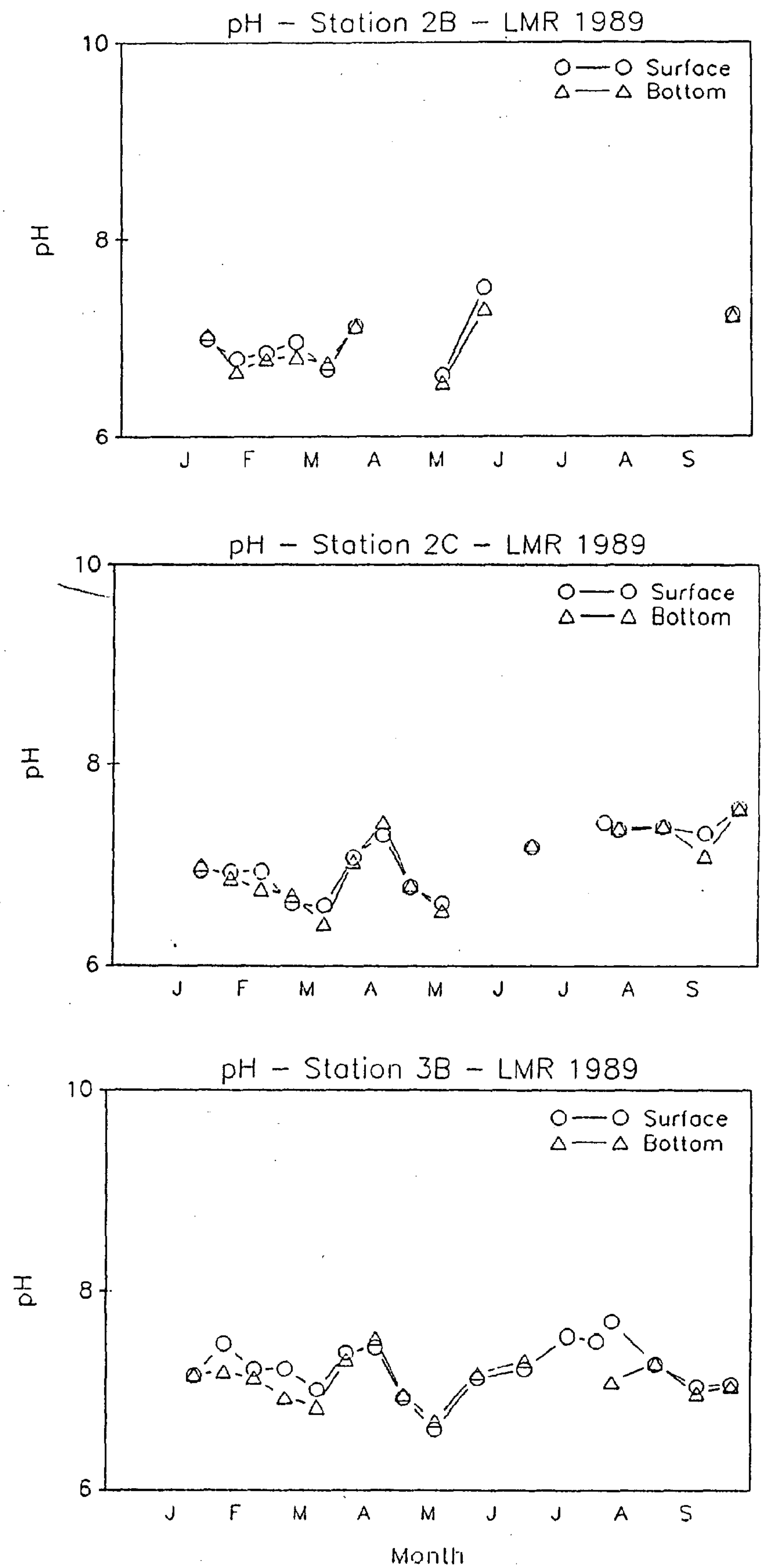

pH - Station 2A - LMR 1989
10
8
6
pH
Surface
Bottom
J F M A M J J A S
Month

FIGURE 18



pH – Station 2B – LMR 1989
10
8
6
pH
O—O Surface
Δ—Δ Bottom
J F M A M J J A S
pH – Station 2C – LMR 1989
10
8
6
pH
O—O Surface
Δ—Δ Bottom
J F M A M J J A S
pH – Station 3B – LMR 1989
10
8
6
pH
O—O Surface
Δ—Δ Bottom
J F M A M J J A S
Month

FIGURE 19

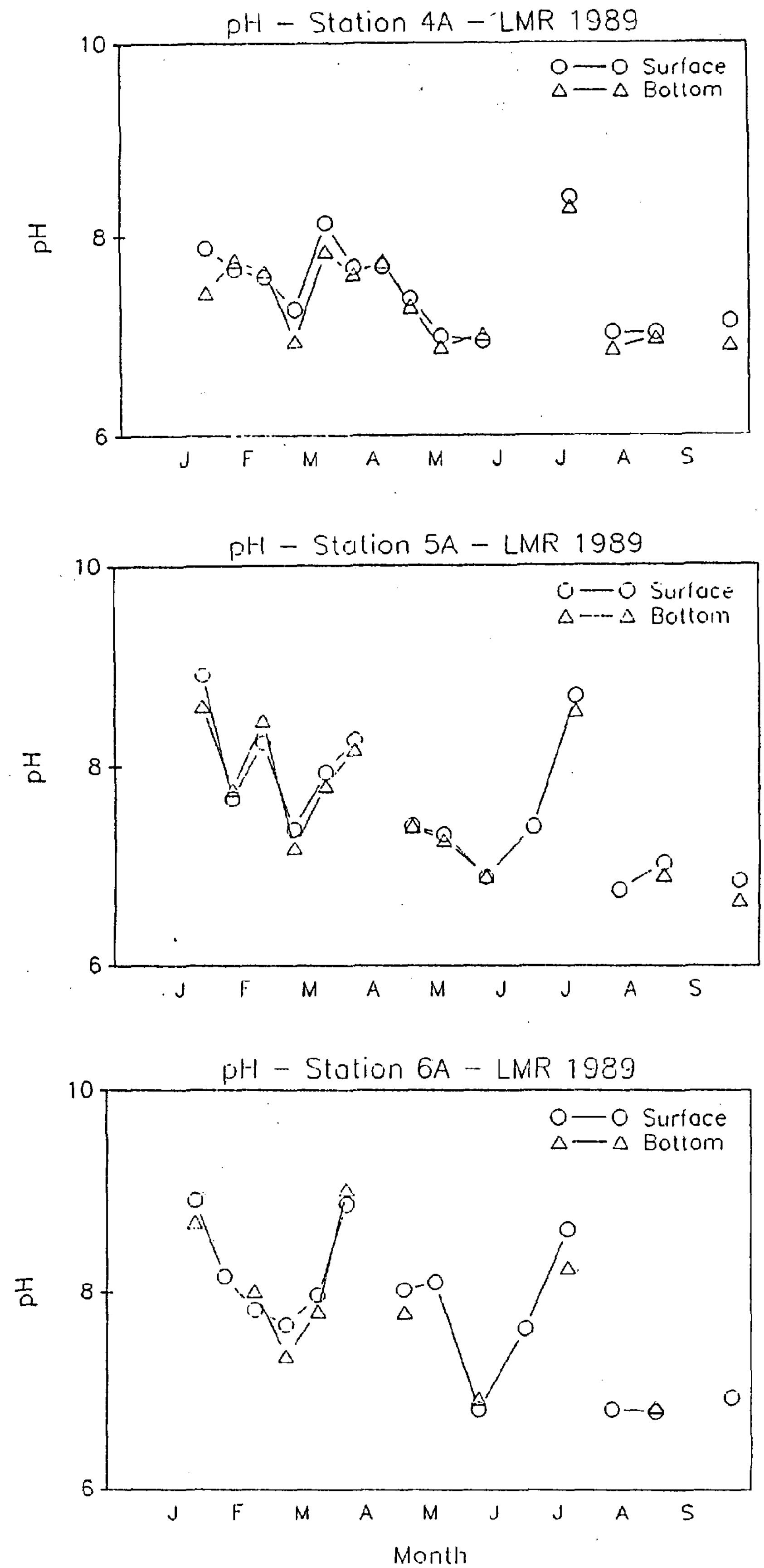
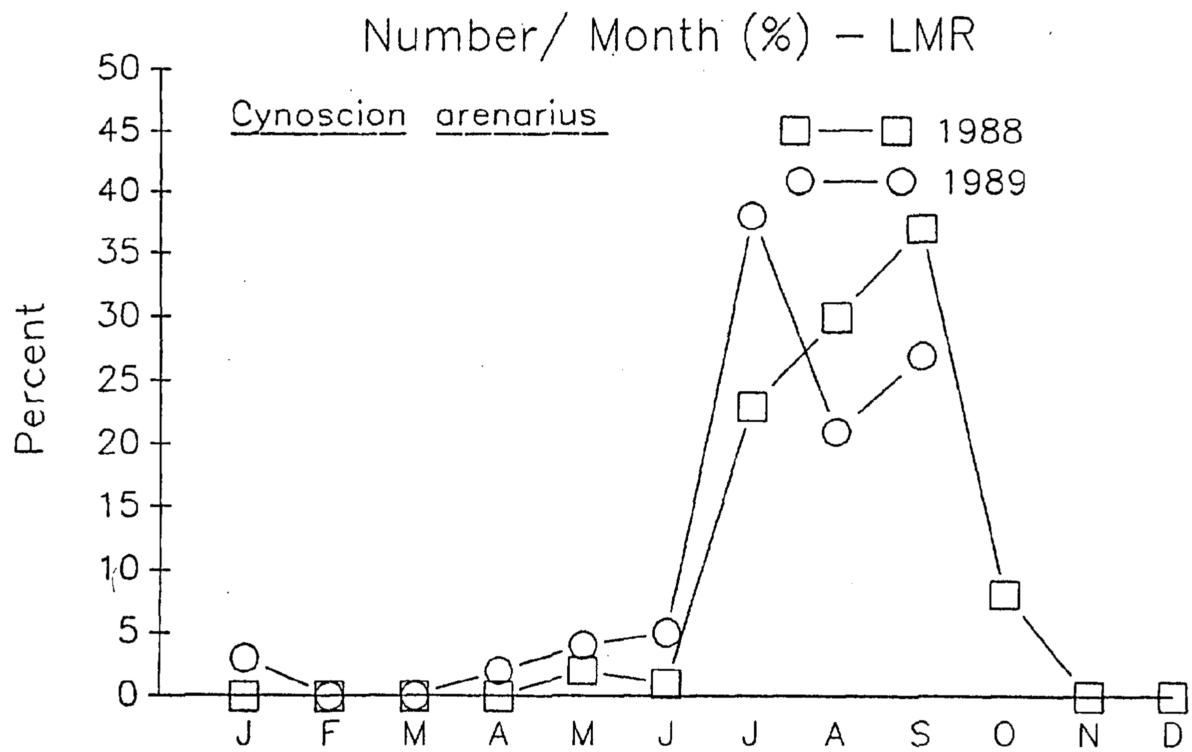

pH - Station 4A - LMR 1989
O—O Surface
Δ—Δ Bottom
pH
10
8
6
J F M A M J J A S
pH - Station 5A - LMR 1989
O—O Surface
Δ----Δ Bottom
pH
10
8
6
J F M A M J J A S
pH - Station 6A - LMR 1989
O—O Surface
Δ—Δ Bottom
pH
10
8
6
J F M A M J J A S
Month

FIGURE 21


Number/ Month (%) - LMR
Cynoscion arenarius
1988
1989
Percent
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D

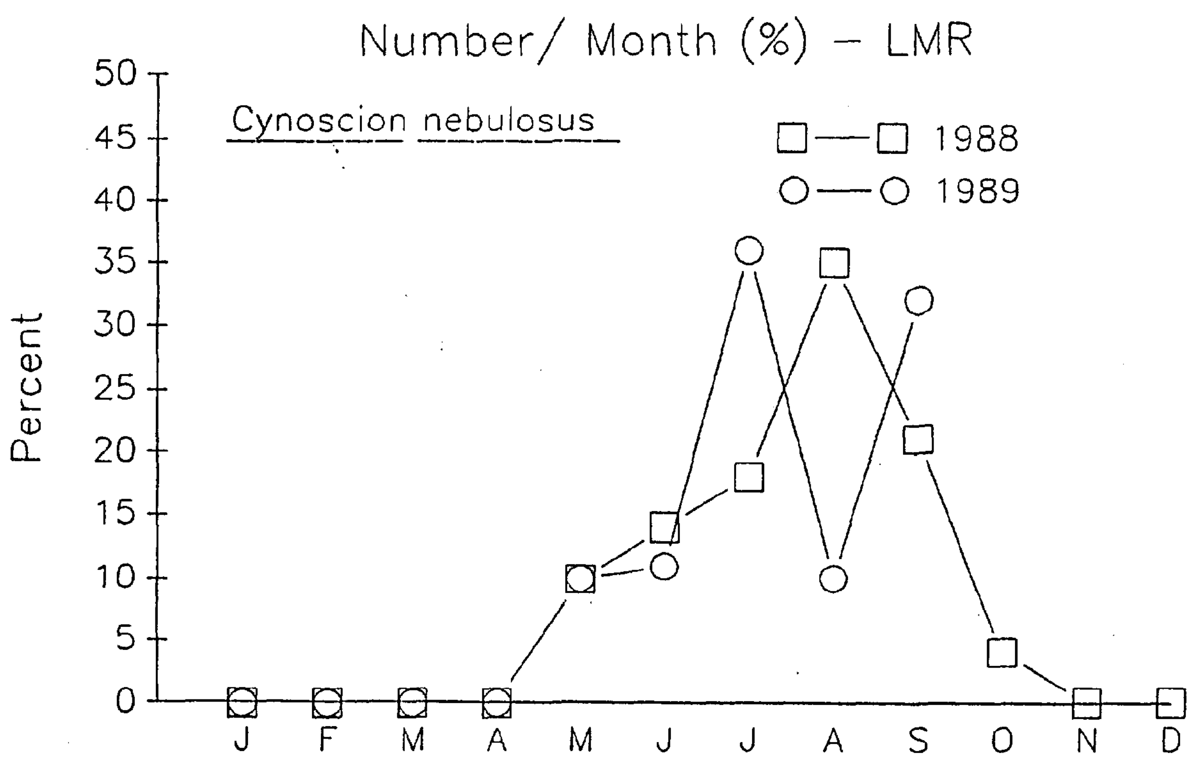
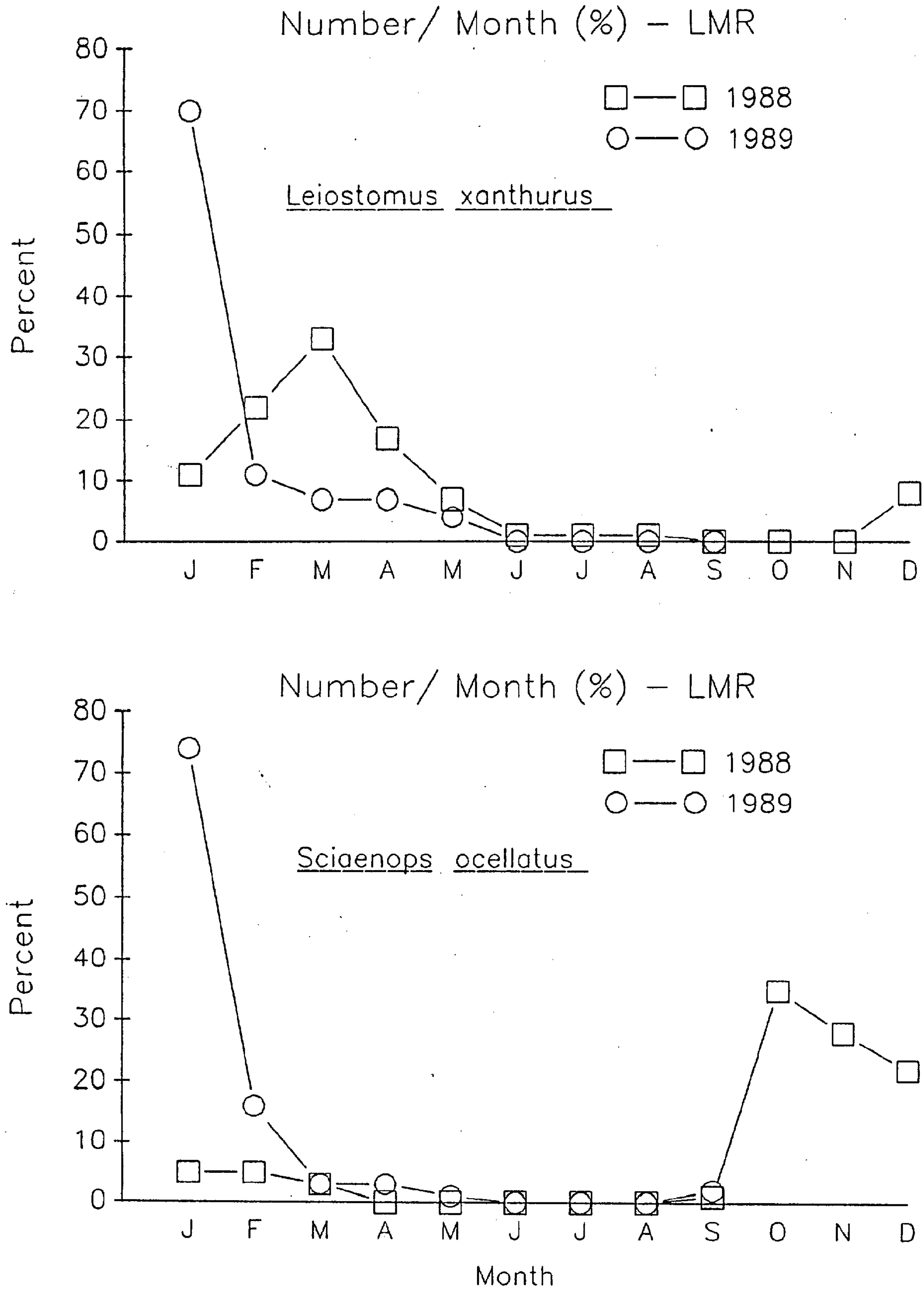

Number/ Month (%) - LMR
Cynoscion nebulosus
1988
1989
Percent
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D

FIGURE 22



Number/ Month (%) - LMR
1988
1989
Leiostomus xanthurus
Percent
80
70
60
50
40
30
20
10
0
J F M A M J J A S O N D
Number/ Month (%) - LMR
1988
1989
Sciaenops ocellatus
Percent
80
70
60
50
40
30
20
10
0
J F M A M J J A S O N D
Month

FIGURE 23

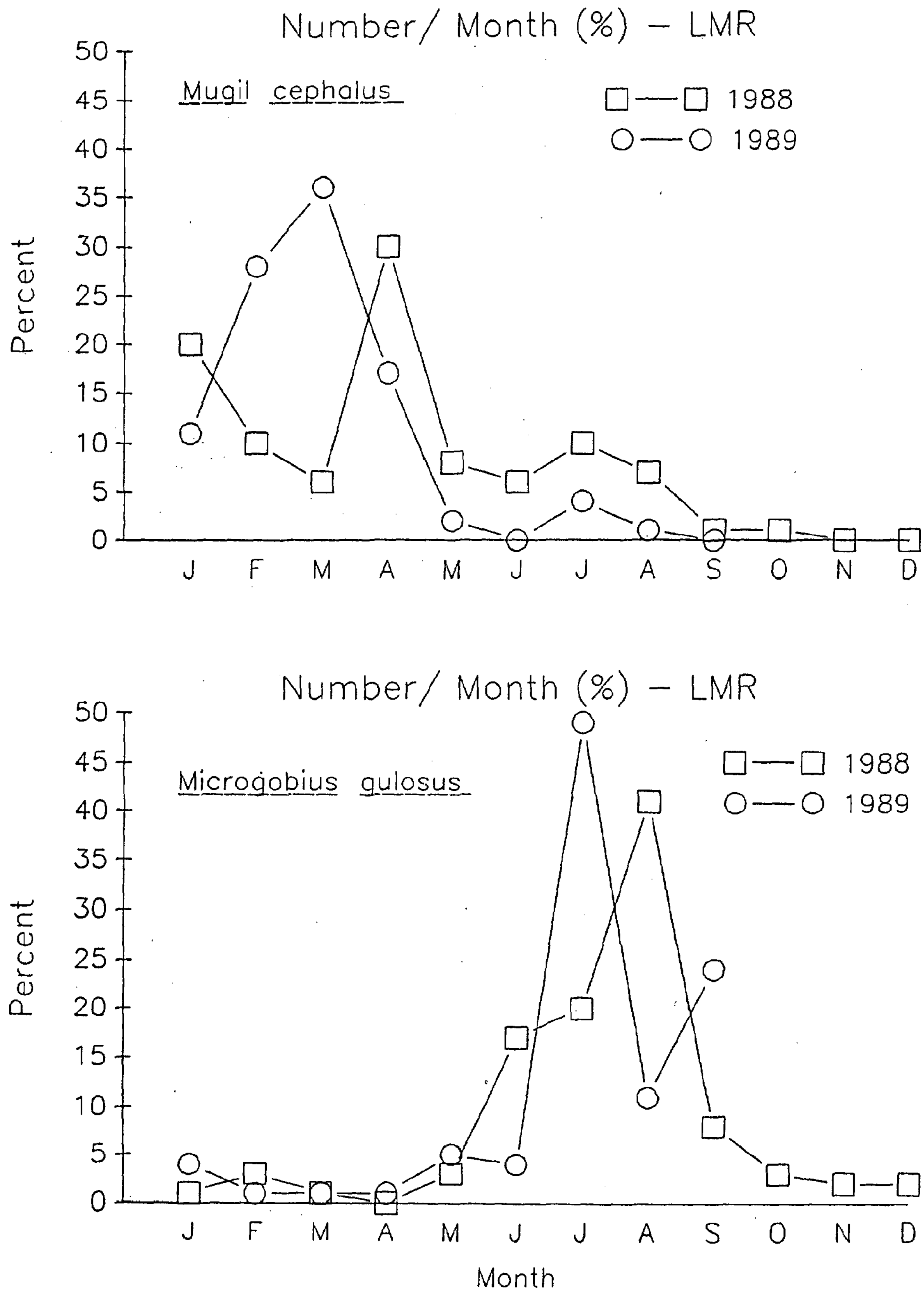

Number/ Month (%) - LMR
Mugil cephalus
1988
1989
Percent
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
Number/ Month (%) - LMR
Microgobius gulosus
1988
1989
Percent
50
45
40
35
30
25
20
15
10
5
0
J F M A M J J A S O N D
Month

FIGURE 24

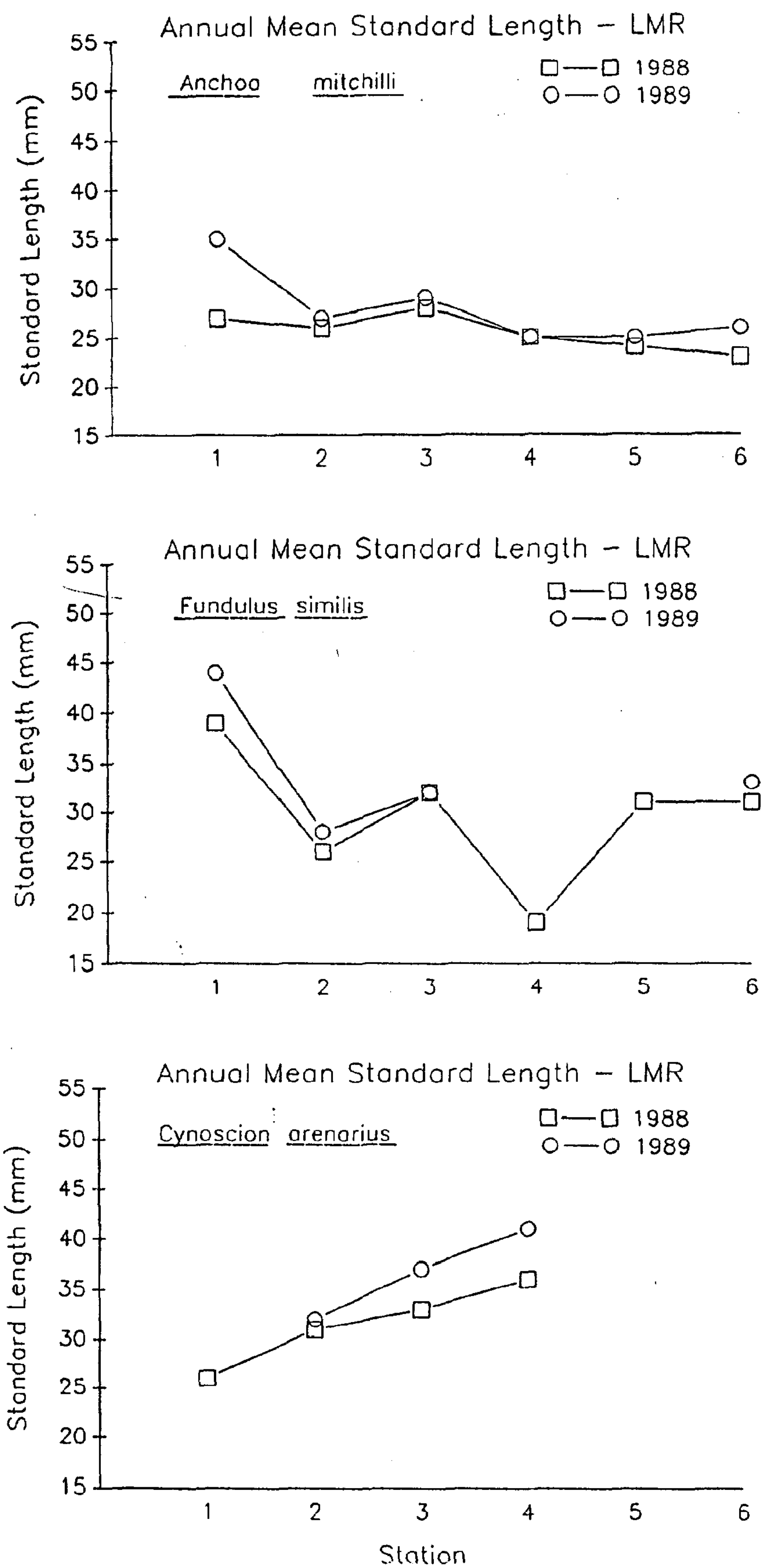
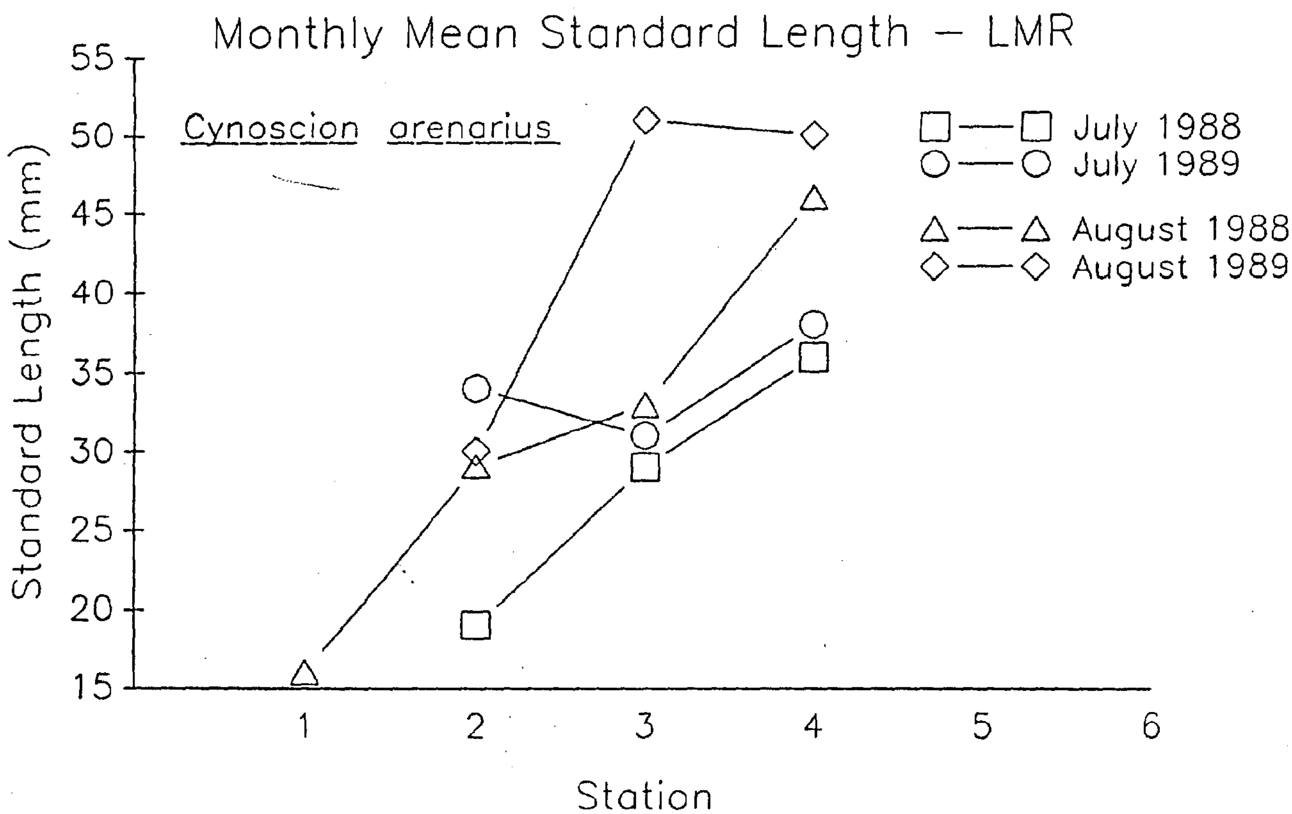

Annual Mean Standard Length – LMR
Anchoa mitchilli
1988
1989
Standard Length (mm)
55
50
45
40
35
30
25
20
15
1
2
3
4
5
6
Annual Mean Standard Length – LMR
Fundulus similis
1988
1989
Standard Length (mm)
Annual Mean Standard Length – LMR
Cynoscion arenarius
1988
1989
Standard Length (mm)
Station

FIGURE 25


Monthly Mean Standard Length – LMR
Cynoscion arenarius
July 1988
July 1989
August 1988
August 1989
Standard Length (mm)
55
50
45
40
35
30
25
20
15
1
2
3
4
5
6
Station

APPENDIX A

Common names of selected fishes from the Little Manatee River and Cockroach Bay. All names based on Robins et al. (1980)[a].

Anchoa mitchilli	bay anchovy
Brevoortia spp.[b]	menhaden
Harengula jaguana	scaled sardine
Opisthonema oglinum	Atlantic thread herring
Fundulus seminolis	Seminole killifish
Fundulus similis	longnose killifish
Lucania goodei	bluefin killifish
Lucania parva	rainwater killifish
Gambusia affinis	mosquitofish
Poecilia latipinna	sailfin molly
Menidia spp.[c]	silversides
Syngnathus scovelli	gulf pipefish
Centropomus undecimalis	snook
Chloroscombrus chrysurus	Atlantic bumper
Eucinostomus spp.[d]	mojarras
Lagodon rhomboides	pinfish
Bairdiella chrysoura	silver perch
Cynoscion arenarius	sand seatrout
Cynoscion nebulosus	spotted seatrout
Leiostomus xanthurus	spot
Sciaenops ocellatus	red drum
Mugil cephalus	striped mullet
Gobiosoma spp.[e]	gobies

Microgobius gulosus	clown goby
Trinectes maculatus	hogchoker

[a]Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea, and W. B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada (fourth edition). Amer. Fish. Soc., Spec. Publ. 12, 174 p.

[b]Including *B. patronus* and *B. smithi*.

[c]Including *M. peninsulae* and *M. beryllina*.

[d]Including *E. harengulus* and *E. gula*.

[e]Including *G. bosci* and *G. robustum*.

TASK III: PHYSIOLOGICAL RESPONSES OF THE SEAGRASS, Thalassia testudinum, TO HYPOXIC STRESS AND LIGHT REDUCTION.

INTRODUCTION

The critical habitat value of seagrass meadows has been demonstrated for hundreds of fish and invertebrate species, prompting concern over worldwide declines in seagrass bed area wherever coastal areas and estuaries are exposed to human development. Dramatic losses of seagrasses have occurred in West Australia, the Caribbean, Europe, and the continental United States. Within the United States, extensive declines of seagrass beds have been documented in the Northeast United States, Chesapeake Bay, and Florida.

The decline of seagrasses in Florida has occurred at an alarming rate. Previous research by DNR personnel, funded by the CZM program, has documented seagrass losses in Tampa Bay, Charlotte Harbor, and the Indian River. Areal declines in seagrass beds have been estimated at one third for Charlotte Harbor and one half for Tampa Bay for the 40 years prior to 1982. Seagrass losses have also occurred in the Indian River lagoon.

While some Florida seagrass beds have been lost directly to dredge and fill, much of the loss has been due to gradual "die-back" of seagrass beds in response to poorly-understood stresses. We use the term "die-back" to describe the gradual decrease in size, density, and productivity of seagrass beds. For reasons which are not clear, turtle grass, Thalassia testudinum, appears to be more susceptible to die-back than the other two seagrass species (Halodule wrightii and Syringodium filiforme). The mechanism most frequently suggested as the cause of seagrass die-back is decreased productivity due to shading. Shading, in turn, may result from sediment resuspension, phytoplankton blooms, or epiphyte growth. All of these processes, in turn, may be accelerated or exacerbated by human activity, perhaps explaining the anthropogenic contribution to seagrass dieback.

Our research has studied the etiology of seagrass die-back processes, based on the underlying hypothesis that natural and anthropogenic stressors, such as shading, cause seagrass die-back by induction of hypoxia (ie. suffocation) or sulfide toxicity in roots or rhizomes. Significant results of CZM-funded research to date in our lab include: 1. Demonstration of sulfide uptake and detoxification by seagrasses using stable sulfur isotope ratios of plant tissue; 2. Thalassia tolerates sediment sulfide concentrations as high as 3 millimoles per liter, considerably more than typically occurs in sediments of Tampa Bay, Charlotte Harbor, or Indian River. 3. Thalassia rhizomes in Tampa Bay, Charlotte Harbor, and Indian River have high levels of ethanol and an enzyme which catalyzes ethanol production (alcohol dehydrogenase, ADH), suggesting that hypoxic stress occurs frequently. We conclude that, while _Thalassia_ is able to detoxify sulfide and survive hypoxic stress under normal conditions, chronic stress, natural or anthropogenic, may cause die-back.

OBJECTIVES

To better understand the adaptation and capacity of _Thalassia testudinum_ and other seagrass species to hypoxia and synergistic, chronic stresses, we outlined three sub-tasks for research this fiscal year.

1. Development and refinement of physiological analysis techniques.

Total free amino acid (TFAA)- concentrations in rhizome tissue are of great interest because 1. free amino acids may be involved in hypoxic stress responses and 2. qualitative amino acid analyses are tedious and expensive. No published technique has proven satisfactory for the simultaneous analysis of primary and secondary amino acids in the same sample, so we modified two existing techniques to make a single procedure which gives reliable estimates of both primary and secondary amino acids on the same sample.

A number of different solvents and treatments have been described in the scientific literature for extraction of amino acids and other proximate constituents from plant and animal tissue. There seem to be important quantitative and qualitative differences among procedures, so we also tested the efficiency of several extraction solvents and treatments in extracting amino acids from freeze-dried _Thalassia_ rhizome tissue.

2. Field experiments to test the synergistic effects of shading on rhizome hypoxia.

Two field experiments were conducted during this fiscal year. In July 1989, we performed a short-term experiment, using a complete, randomized-block design to test the effects of rhizome severance, water column anoxia, and shading on _Thalassia_.

We also performed ethanol and ADH analyses on a long-term _Thalassia_ shading study performed by other FMRI researchers. The study began in March 1989 and was sampled for several growth-related parameters. We sampled hypoxic metabolites on 7 September 1989 to take advantage of shortening daylengths and warm water temperatures which enhance hypoxic stress.

3. Laboratory experiments were also carried out to examine the hypoxic stress responses of the three seagrass species Thalassia testudinum, Halodule wrightii, and Syringodium filiforme, under controlled conditions.

The results of three such experiments are reported below. The first experiment tested differences in aerobic respiration rates and hypoxic responses of Thalassia rhizome apices and mature segments. The second experiment focused on the anaerobic ethanol production rates of Thalassia, while the third measured aerobic respiration rates and anaerobic ethanol production rates of all three seagrass species.

METHODS

1. Physiological Analysis Techniques

Total Free Amino Acid Concentrations (TFAA)- Our technique uses o-phthaldialdehyde (OPA) to create a product with amino acids which can be detected by fluorescence with an excitation wavelength of 405 nm and an emission wavelength of 450 nm. Because OPA reacts only with primary amino acids, we use sodium hypochlorite (NaOCl) to oxidize secondary amino acids, such as proline and hydroxyproline, to primary amino acids.

Freeze-dried Thalassia rhizome tissue was extracted with four solutions: 70% ethanol, 3.75% sulfosalicylic acid, 0.1 N sulfuric acid, and 1.0 N sulfuric acid. Each of these extractions was performed under five treatment conditions: room temperature for one hour, room temperature for four hours, overnight at 40 C, sonication for two minutes followed by one hour at room temperature, and microwaving followed by one hour at room temperature. Extraction of 5-10 mg of tissue with 1.0 ml solvent was performed in 1.8 ml polypropylene micro-centrifuge tubes.

After extraction, tubes were centrifuged, and supernatant (50 ul) from each microcentrifuge tube was transferred to each of two fluorometers cuvettes containing 2.5 ml distilled water. OPA reagent (2.5 ml) was added immediately to one cuvette of each pair for the analysis of primary amino acids. Secondary amino acids (proline and hydroxyproline) were measured in the other cuvette by adding sodium hypochlorite buffer (100 ul) and microwaving for 20 seconds before addition of OPA reagent. The fluorescence of the OPA/amino acid complex was measured using a Turner Model 111 fluorometer with F4T5B lamp, 7-60 primary filter, and paired 5-60 and 3 secondary filters.

2. Field Experiments

The short-term experiment used a complete, randomized-block, experimental design to test the effects of three variables on rhizome gas concentrations and hypoxic stress. The variables tested were 1. presence or absence of light, 2. water column oxygen status, and 3. rhizome integrity. Light was excluded from dark treatments by inverting an opaque 5-gallon bucket over a circular patch (30 cm diameter) of seagrass bed; light treatments had no bucket over them. Water column oxygen concentrations were manipulated by covering patches of seagrass with clear plastic sleeves: we anticipated that oxygen dissolved in water within the sleeves would be rapidly depleted at night. Dark/Aerobic treatments were covered by inverted, opaque buckets through which ambient water was circulated by small, submersible bilge pumps. Rhizome integrity was disrupted by enclosing plots with buckets and cutting rhizomes around the exterior perimeter of buckets. Two replicate 5-gallon buckets were used for each treatment. Buckets were placed over seagrass plots at 1300-1500 h one day, and samples were harvested from each bucket the following afternoon.

We also sampled ADH and ethanol concentrations in Thalassia rhizome tissue from a long-term shading study. Six replicate plots of Thalassia, 3 in approximately 1.0 m deep water and 3 in approximately 1.8 m deep water, were shaded with neutral density screen. Shade treatments began March 1989, and we sampled rhizome tissue in September 1989.

3. Laboratory Experiments

Methods for all seven lab experiments were similar. Rhizomes with an intact apex and at least two photosynthetic short shoots were collected from Tampa Bay or Florida Bay seagrass beds. Rhizome segments were surface-sterilized by immersion in 10% Chlorox/seawater and antibiotics (polymixin/nitrofurantion, 250 mg of each per liter ASW).

Tissues were incubated in 10 glass, closed, 20-ml syringes with air headspaces for 24 hours before being flooded with a helium headspace to induce hypoxic stress. Syringes were incubated in the dark, immersed in seawater to maintain temperature stability and reduce diffusive fluxes between the syringe headspace and the atmosphere.

Headspace gas concentrations were monitored periodically by gas chromatography. In early experiments, ethanol production was measured in the headspace of the syringe, as well. However, tissue was harvested for ethanol in later incubations.

4. Statistical Analyses- for all experiments were performed using one- and two-way analyses of variance and Duncan's multiple range tests (SAS Institute, 1987).

RESULTS AND DISCUSSION

1. Physiological Analysis Techniques (TFAA)-

OPA (o-pthalaldialdehyde) is typically used for pre- or post-column derivatization of amino acids for HPLC. However, our adaptation of the reagent to a manual technique produced reproducible, linear, standard curves for all primary amino acids tested in the concentration range from 0.5 to 40 umoles/liter (Figure 1.1). Slopes of standard curves for glutamine, glutamic acid, arginine, glycine, and alanine were not signficantly different, especially when the OPA reagent was made freshly each morning. The F4T5 lamp, used with the 7-60 primary filter, gave a higher blank value than the F4T4 lamp. The F4T5 lamp was chosen for the analysis because it caused less rapid degradation of the fluorescent OPA-amino acid product. Minimum blank values were obtained using freshly-made OPA reagent and double-distilled water for dilution of samples.

Standard curves for proline determined by hypochlorite oxidation before reaction with OPA had slopes approximately 1/3 those of primary amino acids. Yield was not significantly altered by changing the strength or volume of oxidizing buffer or by increasing the microwave exposure time. The consistency of the slopes for the proline standard curve, however, suggested that 1. oxidation of proline by hypochlorite was quantitative, but 2. the proline-OPA product may have had less intense fluorescence. Approximately 7% of the primary amino acid remained after oxidation, making it necessary to correct calculated concentrations of secondary amino acids for residual primary amino acids.

Results of the extraction experiment (Table 1.1) showed that no single combination of solvent and treatment yielded the highest recovery of both primary and secondary amino acids from *Thalassia* rhizomes. Greatest recoveries of primary and secondary amino acids from *Thalassia* rhizome tissue were obtained by sonication with sulfosalicylic acid (3.75% aq) and extraction with sulfuric acid (1.0 N) for 24 hours at 4 ^{o}C, respectively. The latter treatment, however, was unsuitable because it significantly decreased recoveries of primary amino acids.

The two techniques yielding the best overall extraction efficiencies for both primary and secondary amino acids were 1) sonication with 3.75% sulfosalicylic acid and 2) sulfuric acid (1.0 N) extraction at room temperature for 1 hour. The sulfosalicylic acid technique recovered 100% and 87.4% of primary and secondary amino acids, respectively. Sulfuric acid (1N) held at room temperature for 1 hour extracted 88.1% of the primary amino acids and 97.9% of the secondary amino acids. The overall extraction efficiencies of the two techniques were 94.9% for 1 N sulfuric acid and 91.2% for sulfosalicylic acid.

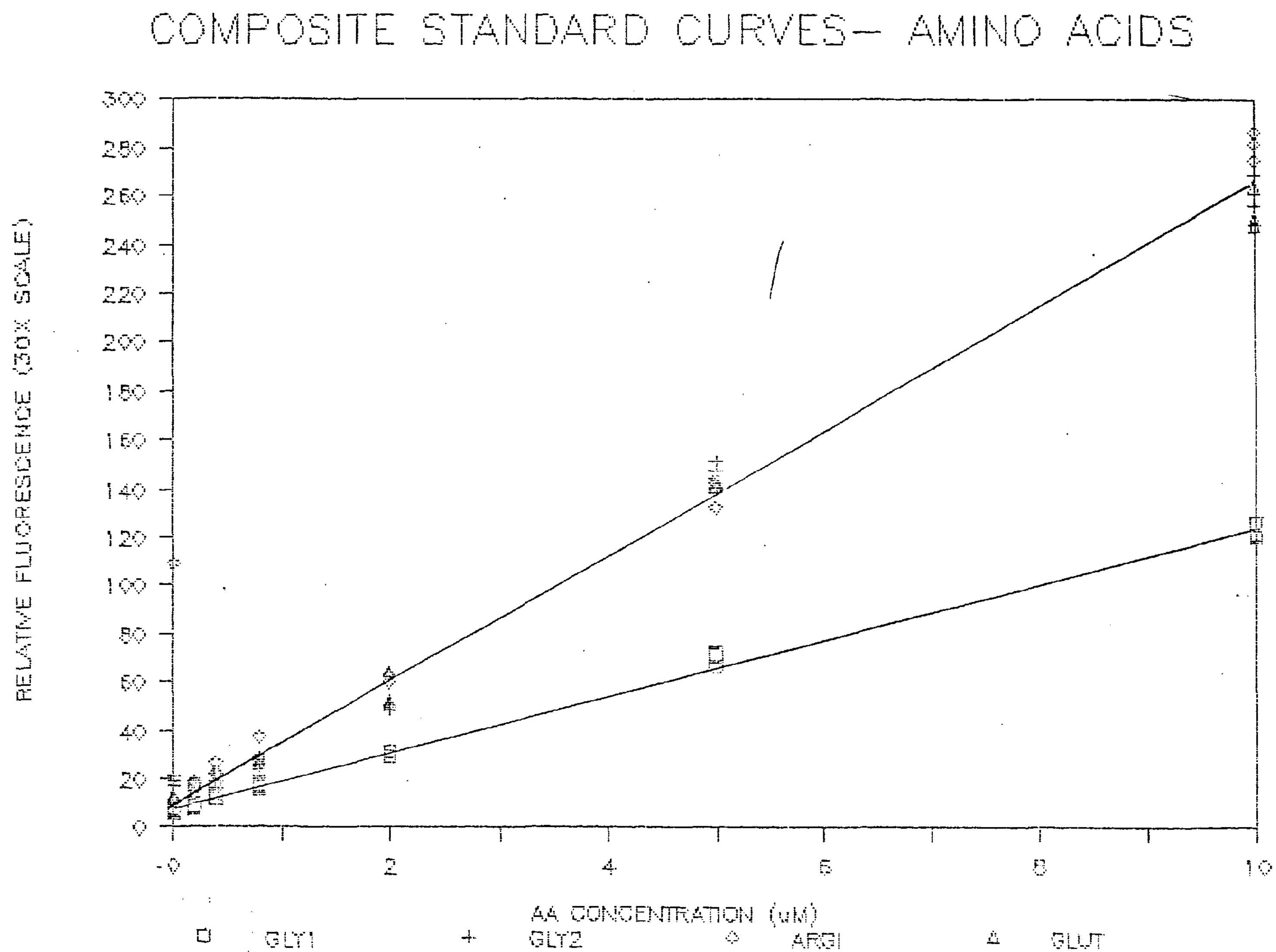


FIGURE 1.1: STANDARD DURVES FOR AMINO ACIDS MEASURED WITH OPA. Upper curve - F4T5 lamp with 7-60 primary filter. Lower curve - F4T4 lamp with 7-60 and 1% neutral density filters.

TABLE 1.1: EFFECT OF EXTRACTION SOLVENT AND TREATMENT ON AMINO ACID RECOVERY FROM THALASSIA RHIZOMES
Data are means of three replicate samples expressed as micromoles amino acid per gram dry weight rhizome
Within each group of amino acids, numbers with the same postscript are not significantly different.

	TREATMENT				
	Room Temperature				
Solvent	1 Hour	4 Hours	Sonicate	Microwave	24 Hours at $4^{o}C$
A. Primary Amino Acids					
Ethanol (70%)	104.9 f	122.3 de	122.6 de	80.5 g	116.7 ef
H_2SO_4 (0.1 N)	146.3 ab	144.2 abc	147.2 ab	141.4 abc	134.6 bcd
H_2SO_4 (1.0 N)	136.4 bcd	140.5 abc	134.7 bcd	140.6 abc	134.4 bcd
Sulfosalicylic Acid (3.75%)	144.4 abc	148.3 ab	154.9 a	128.3 cde	138.9 abcd
B. Secondary Amino Acids					
Ethanol (70%)	182.0 ef	113.1 hi	145.5 fgh	90.1 i	172.8 ef
H_2SO_4 (0.1 N)	203.9 e	112.6 hi	184.6 ef	124.5 ghi	172.7 ef
H_2SO_4 (1.0 N)	351.8 ab	199.7 e	321.8 bc	201.4 e	359.5 a
Sulfosalicylic Acid (3.75%)	286.4 cd	166.4 ef	314.1 c	158.8 fg	270.9 d

2. Field Experiments-

The short-term experiments performed at Fort Desoto, July 19, 1989 demonstrated the physiological integration of *Thalassia* short shoots (Table 1.2). Light/dark treatments had only marginally significant effects on rhizome oxygen concentrations and no effects on rhizome carbon dioxide and methane. Restricted circulation in the water above the experimental plots (open/closed treatments) had virtually no effect on rhizome carbon dioxide and oxygen and a very small effect on rhizome methane. Cutting rhizome connections around the perimeter of each bucket, however, caused dramatic effects on all three gases within *Thalassia* rhizomes. These data indicate a high degree of physiological integration among short shoots along a given rhizome, allowing photosynthetically-active short-shoots to support the oxygen needs of rhizome apices growing at depth in the sediments.

Responses of *Thalassia* to the field shading treatments were mixed (Table 1.3). Although Hall (et al.) found statistically significant differences in turnover time of above-ground biomass between their deep shade treatment and all other treatments, there were no significant differences in rhizome ADH activity among the treatments. Ethanol was undetectable in all but three samples from the entire experiment and showed no significant day/night or treatment-related differences.

Lack of hypoxic stress responses in the shading experiment may be due to the high wave energy, coarse-grained sediments, and low turbidity at this site. Even *Thalassia* in the deep shade treatment at this site may receive sufficient light to meet the respiratory needs of its belowground tissue, especially if the chemical and biological oxygen demand of the sediments is low.

Turnover times of above-ground biomass from this site and a turbid, low-energy site sampled by Carlson and Acker (1985) support this hypothesis. Turnover times measure the time required for the plant to replace its total inventory of leaf and shoot material; healthy, fast-growing plants generally have low turnover times. When plants are stressed, turnover times increase as the result of slower growth rates and longer retention times for leaves. At the low-energy site, significant growth reduction occurred within 3 weeks after shade treatments began. At the present site, 6 months elapsed before significant changes in turnover time developed. Furthermore, the turnover times for unshaded, control treatments at the low-energy site were comparable to the deep shade treatment at the high-energy site. Turnover time of shaded *Thalassia* at the low-energy site was double that of the deep shade treatment and five times greater than the shallow shade treatment.

TABLE 1.2: ANALYSIS OF VARIANCE FOR SHORT-TERM HYPOXIA FIELD EXPERIMENTS. Fort DeSoto, July 19, 1989. A. Analyses of variance- Data are F-Ratios and p-values; Values of p $\leq$ 0.05 denote significant effects of independent variable (treatment) on dependent variables (gas concentrations). B. Multiple Range Tests- Data are gas concentrations; values within each horizontal line which have the same letter subscript are not significantly different.

A. Analysis of Variance

Treatment	Rhizome Gas Concentration (%)					
	Carbon Dioxide		Oxygen		Methane	
	F-Ratio	P	F-Ratio	P	F-Ratio	P
Light/Dark	0.03	0.86	2.84	0.11	1.25	0.28
Aerobic/Anoxic	0.00	0.99	0.00	0.96	1.17	0.29
Rhizome Cut	5.58	0.03*	7.56	0.01*	19.7	0.0003*

B. Multiple Range Tests

Parameter	Treatment							
	DCC	DCU	DOC	DOU	LCC	LCU	LOC	LOU
Methane	6.5 a	3.2 abc	5.6 ab	2.4 bc	nd	2.3 bc	4.4 abc	1.9 c
Oxygen	13.4 ab	13.5 ab	6.2 b	20.6 a	nd	22.1 a	15.2 ab	23.1 a
Carbon Dioxide	6.6 ab	7.3 ab	11.5 a	2.9 b	nd	5.4 ab	8.5 ab	4.6 ab

TABLE 1.3: GROWTH AND PHYSIOLOGICAL CHARACTERISTICS OF SHADED *Thalassia testudinum*. Tampa Bay shading study sampled September 5-9, 1989. Numbers within each column which have the same letter postscript are not significantly different.

		Parameter			
Site	Treatment	ADH Activity (umol/gFW min)	Ethanol (umol/gFW)	Turnover[1] (days)	Turnover[2] (days)
Shallow	Control	4.17 a	ud	30.2 a	118 a
	Shade	4.27 a	ud	49.9 a	227 b
Deep	Control	4.61 a	ud	44.7 a	--
	Shade	4.18 a	ud	112.4 b	--

1 Hall, Tomasko, and Courtney (in preparation)
2 Carlson and Acker (nearby site, 1985)

3. Laboratory Hypoxia Experiments-

In initial laboratory experiments (Table 1.4), rhizome alcohol dehydrogenase (ADH) activity was significantly higher in mature rhizome segments exposed to anaerobic conditions for 96 hours than initial samples or rhizome tissue incubated in air for a comparable period. Over 96 hours, however, apical ADH activity declined significantly from initial values. ADH activity of mature and apical tissue incubated in air for 96 hours were not signficantly different from initial values. This experiment demonstrated 1) that ethanol production is the primary adaptive strategy of *Thalassia* for tolerating rhizome hypoxia, but 2) the capacity of rhizome apices to sustain prolonged periods of stress is less than that of mature rhizome segments.
Estimation of rhizome ethanol concentrations from the concentrations in syringe headspace proved unreliable because of the high solubility of ethanol in water. If any water was present in a syringe, the water rapidly scavenged ethanol from the headspace. Subsequent experiments relied on destructive sampling of the rhizome tissue at the end of each incubation and/or sequential harvest of tissue during the incubation.

Experiments using sequential harvest of rhizome tissue were very successful. The first experiment used only apical tissue from *Thalassia* rhizomes (Figure 1.2), and segments were harvested at varying intervals from 1 to 48 hours. Mean ethanol production rate for the experiment was 1.1 umoles per gram fresh weight rhizome per hour. Anaerobic carbon dioxide production rates were 0.87 umoles/ gram/ hour, suggesting slight losses of CO_2 to dissolution in the water present.

Preliminary experiments comparing mature rhizome segments of *Halodule*, *Syringodium*, and *Thalassia* demonstrated signficant rates of ethanol production under anaerobic conditions for all three species (Figure 1.3). *Halodule* rhizome segments had the highest ethanol production rates (1.73 umoles gFW^{-1} $hour^{-1}$), *Syringodium* was intermediate with 0.85 umoles gFW^{-1} $hour^{-1}$, and *Thalassia* had the lowest rates (0.61 gFW^{-1} $hour^{-1}$). Lower rates for *Thalassia* in this experiment than the previous experiment probably resulted from lower incubation temperatures ($25^{o}C$ vs $30^{o}C$).

CONCLUSIONS

Ethanol production (fermentation) is an extremely primitive and costly strategy for tolerance of anoxia, yet it is consistent with the taxonomic ranking of *Thalassia* in the botanical family Hydrocharitaceae. This family includes many seagrasses and aquatic macrophytes. Its costliness arises from the fact that each mole of glucose which is oxidized anaerobically will produce only 2 moles of ATP for cellular metabolism rather than 38 moles of ATP produced by aerobic respiration. At the same time, ethanol is auto-toxic to plant tissue, so many ethanol-producing

TABLE 1.4: ETHANOL AND ALCOHOL DEHYDROGENASE PRODUCTION IN RHIZOMES OF _Thalassia testudinum_. Rhizome Hypoxia Experiment 2. Aerobic and anaerobic incubations were held for 96 hours in glass syringes filled with air and helium, respectively. ADH activity is expressed as umoles ethanol per gram fresh weight rhizome tissue per minute; ethanol concentration as umoles per gram fresh weight rhizome tissue.

		Treatment	
Parameter/ Tissue	Initial	Aerobic	Anaerobic
Alcohol Dehydrogenase Activity			
Rhizome Apex	4.89 bc	4.44 b	2.34 c
Mature Rhizome	3.68 bc	3.06 bc	8.16 a
Headspace Ethanol			
Rhizome Apex	nd	0.01	0.51
Mature Rhizome	nd	0.07	0.83

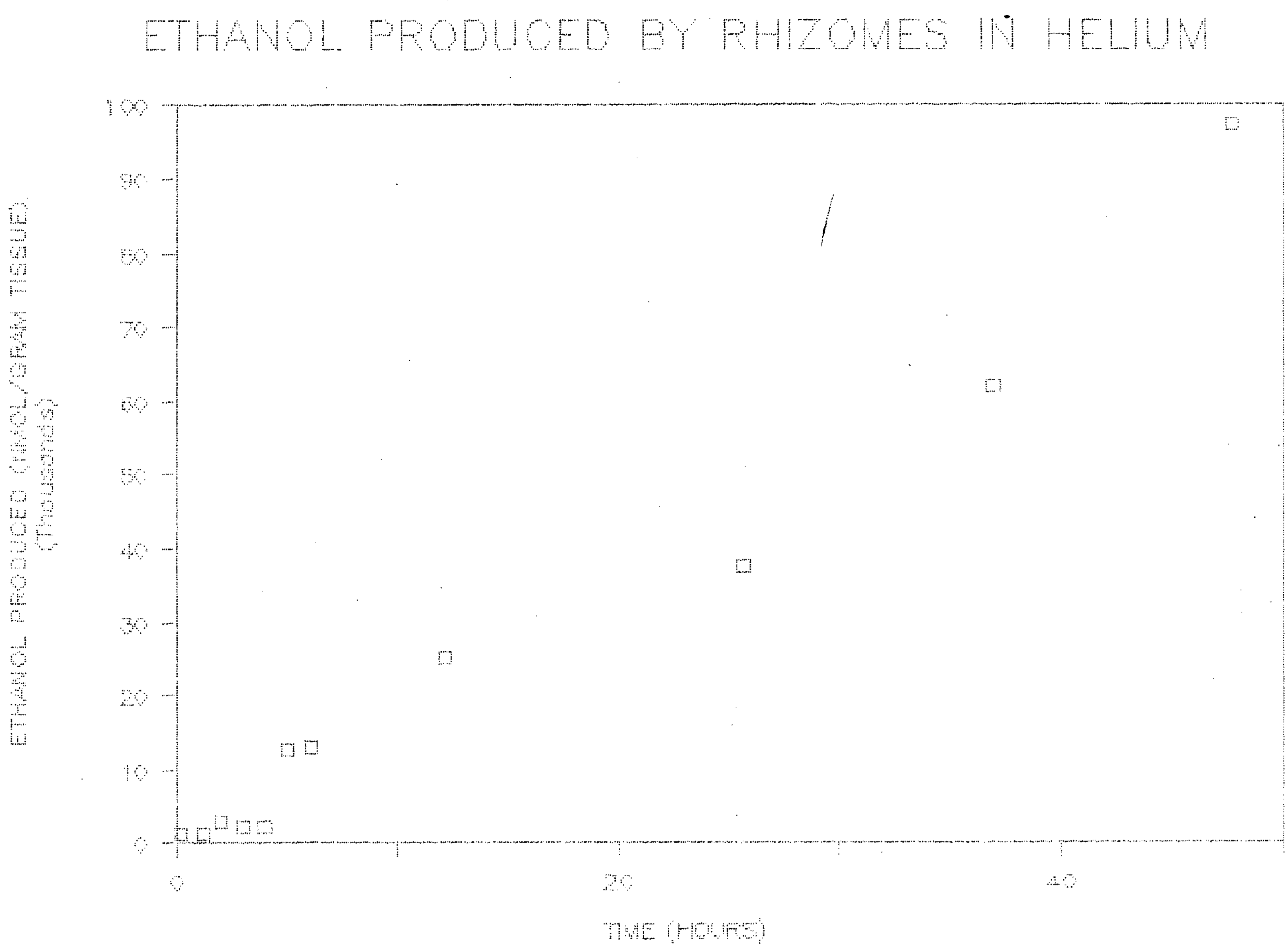


Figure 1.2: TIME COURSE PRODUCTION OF ETHANOL BY THALASSIA RHIZOMES IN HELIUM ATMOSPHERE.

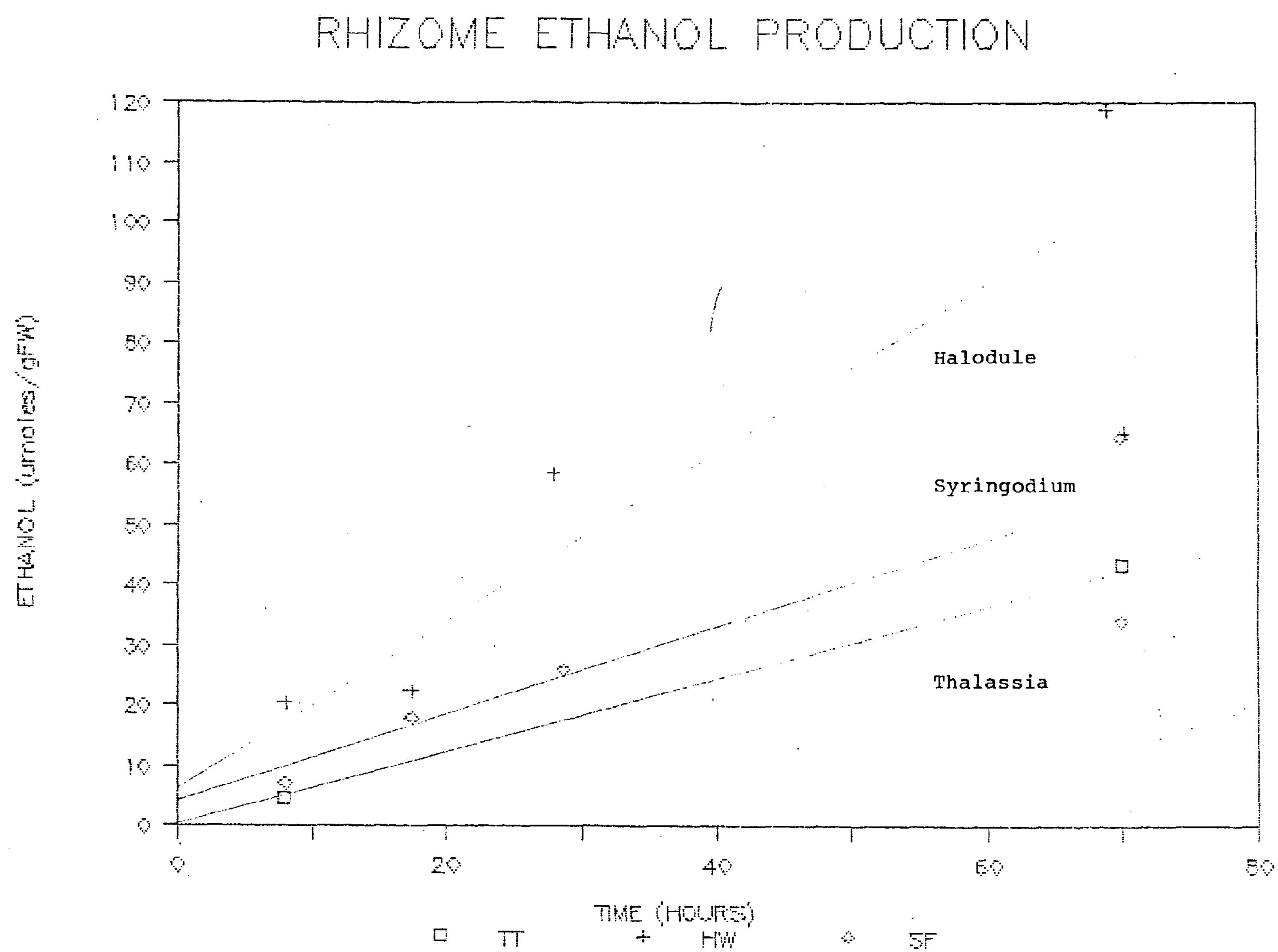


FIGURE 1.5: PRODUCTION OF ETHANOL BY SEAGRASS RHIZOMES IN HELIUM ATMOSPHERE.

species have adapted to allow ethanol to diffuse rapidly from their roots into the surrounding sediments or water. Ethanol diffusing into seagrass sediments may also exacerbate sulfide stress by stimulating anerobic sulfate-reducing bacteria.

Organisms in fluctuating environments typically possess both avoidance and adaptive responses to stressors. For example, mobile organisms exposed to hypoxic water may first avoid stress by leaving the area. However, if an extensive area is affected, these same organisms may become quiescent and lower their respiratory rates in response to lowered oxygen concentrations in the water. Not all organisms have evenly balanced avoidance and adaptive strategies for stressors; frequently one strategy, either avoidance or adaptive, dominates within an organism.

The reliance of Thalassia on fermentation as a adaptive response to anoxia may result from its well-developed adaptations for avoiding anoxia. Thalassia possesses a well-developed system of air spaces (lacunae or aerenchyma) which provide a continuous path for photosynthetically-produced oxygen to diffuse to belowground tissue. Under all but the most extreme conditions, this mechanism protects belowgroung tissues from hypoxic conditions in surrounding sediments. However, when respiratory rates are high and oxygen production is minimal (e.g., late summer nights), fermentation provides a short-term adaptive response and maintains tissue viability.

We must also consider the possibility of endosymbiotic micro-organisms in seagrass roots and rhizomes which oxidize ethanol and prevent autotoxicity within the plant. Ethanol-oxidizing symbionts would explain discrepancies between potential ADH activities measured in rhizome tissue and rates of ethanol production in laboratory incubations of root and rhizome tissue.

A. Effect of carbon source on Thalassia growth and carbon isotopic composition.

A general assumption in past studies using stable isotope compositions of organic matter to trace carbon flow in ecosystems is that the isotopic compositions of organic matter sources are distinctive and relatively invariate (Benner et al., 1987). However, seagrass carbon isotopic composition is subject to variation at several levels and these variations may lead to ambiguities in assessing their trophic importance (Fry et al., 1987). Both laboratory and field studies suggest that this variation may be due to isotopic changes in dissolved inorganic carbon (McMillan and Smith, 1982; Zieman et al., 1985). The goal of this research task is to elucidate, in a more definitive manner, the magnitude (and possibly the mechanism) of these effects. Two approaches have been employed. The first approach has been to culture Thalassia seedlings in natural sediments and ashed sediments ammended with heavy end member (dried Thalassia leaves, del ^{13}C=-6 to -12 ppt) and light end member (dried Aviccenia, del ^{13}C= -25 to -30 ppt) organic matter. Other treatments include no amendment (control), a standard growth media (Jiffy-7 peat pellets, del ^{13}C= -27 ppt), and ashed sediments bubbled with CO_2 gas, which is isotopically very light (del ^{13}C=-40 to-60 ppt). This last treatment was used to induce a maximum potential shift effect.

Because of the presence of microorganisms in the above system, observed patterns may be affected by the extent of carbon cycling and the relative contributions of DIC versus DOC. Therefore a second experimental system was employed which used a similar experimental design as above, except with sterile media and axenic seedlings. The results from this series should allow for the determination of source (DIC vs DOC) versus process (i.e. remineralization) effects.

Growth, as determined from green leaf area measurements (Durako and Moffler, 1981), was monitored monthly. After three, six, and nine months in culture, four seedlings from each treatment were harvested for biomass determinations. Overlying water and new leaf material was also sampled and the del ^{13}C values of DIC and organic matter was determined using standard methods.

RESULTS

Biomass data from aquarium cultures indicate a high degree of variability in biomass accumulation and resource allocation patterns (Table 1). The decrease in biomass between 3 and 6 months in culture was the result of a breakdown of the temperature control equipment in the culture room. This resulted in extreme temperature fluctuations for a several day period and the seedlings were visibly stressed. The continued decline in biomass from 6 to 9 months indicates that the seedlings never fully recovered from the earlier stress event. Growth (as biomass accumulation) was highest in the natural sediment treatment at 6 months, however, by 9 months biomass was comparatively greater in both amended-sediment treatments and in the ashed sediments. The relativley high root:shoot (R:S) ratios inthe ashed sediment and natural sediment treatments indicate that these seedlings may be experiencing some type of nutrient limitation. Relatively good growth was also evident in the _Avicennia_-ammended sediment treatment and these seedlings had low R:S ratios indicating nutrient sufficiency.

Stable carbon isotope data from the aquarium treatments reveals the influence of carbon source and concentration on seedling isotope signatures (Table 2). Del^{13}C values for the peat pellets and the Avicennia leaves are about -26 ppt, compared to the value for the Thalassia leaves of about -10 ppt. The leaves of the seedlings were 1.5-2.0 ppt lighter in the former treatments compared to the latter (mean= -13.1 and -13.5 compared to -11.54), after 6 months in culture. However, after 9 months seedlings in the Thalassia-amended sediment treatment were lighter (mean=-22.2 compared to -18.3 and -21.0).

The importance of dissolved inorganic concentration (DIC) is most clearly seen in the CO_2 bubbled and control treatments. The del^{13}C value for the CO_2 gas used for the first three months was -11.3 ppt (surprisingly heavy and due to the synthetic source of the gas, a problem which was corrected at month 3 with gas from another supplier). This del^{13}C value is almost the same as the normal value for Thalassia. However, the del^{13}C values for the seedlings in this treatment were very light (mean= -24.67). The bubbling resulted in 4-fold increase in DIC, and the much lighter carbon isotope values of the seedlings reflect greater isotopic descrimination at the enzyme level. In contrast, DIC concentrations were lowest in the control treatment and the seedlings in this treatment had relatively heavy carbon isotope signatures. In fact, the trend in isotopic discrimination (del del^{13}C the difference between the DIC and the plant del^{13}C values) in all treatments corresponded closely with the differences in DIC concentrations (increasing as [DIC] increased), suggesting differing degrees of carbon limitation. The increase in discrimination may also reflect a decreasing carbon contribution from stored seed reserves (del ^{13}C of seed approximately -7 ppt).

Biomass data from axenic tube cultures indicate that no root production in media with organic carbon additions (Table 3). There was also little biomass difference between the light and dark treatments suggesting the seedlings were using stored seed reserves for most of their growth. Seedlings in sucrose-amended Von Stosch media accumulated more biomass after 3 months in culture, but after 6 months they had less biomass, especially in the shoot fraction, than seedlings in unamended VS media.

Del ^{13}C data from the axenic seedlings reveals definite assimilation of sucrose (Table 4). Seedlings in both the 1 and 3% enriched media had del^{13}C values that were significantly more negative than the other treatments. There also seems to be additional isotopic discrimination in the light versus dark-cultured seedlings. Because of the low number of surviving axenic seedlings in the _Thalassia_ and _Avicennia_ enriched media it's impossible to state if there was an effect in the del ^{13}C signature.

These results, while preliminary, do show the high degree of variability which may occur in stable carbon isotope composition of _Thalassia_ (range observed in this work: -4.5 to -57.1 ppt PDB). The interaction between organic carbon sources and DIC concentration on this species' stable carbon isotope signatures may help in understanding its physiological characteristics and needs to be understood before this technique can really be used to trace organic carbon through food webs.

Table 1. Biomass (mg) and resource allocation patterns in *Thalassia* aquarium seedling cultures [means (+/- S.D.), n=4].

Treatment	Age (months)	Root	Shoot	Seed	Total	Seedling (root+shoot)	Root/Shoot
Natural sediments	3	83.1 (26.7)	69.8 (10.5)	156.1 (62.2)	309.0	152.9	1.19
	6	60.4 (14.8)	58.3 (22.9)	99.3 (42.5)	218.0	118.7	1.04
	9	39.4 (19.6)	44.8 (10.9)	42.4 (8.3)	126.6	84.2	0.87
Peat pellets	3	46.9 (18.0)	45.9 (5.8)	74.3 (15.7)	167.1	92.8	1.02
	6	27.2 (7.7)	44.2 (8.9)	49.8 (17.4)	121.2	71.4	0.64
	9	31.1 (9.2)	51.4 (23.4)	36.7 (7.3)	119.2	82.5	0.64
Ashed sediments + CO_2	3	31.8 (24.0)	61.7 (6.6)	86.4 (6.0)	179.9	93.5	0.51
	6	31.6 (7.8)	46.0 (8.3)	65.8 (17.9)	143.4	77.6	0.69
	9	31.1	24.6	42.4	98.1	55.7	1.26
Ashed sediments + *Avicennia*	3	28.8 (12.4)	70.5 (41.1)	169.9 (202.4)	269.2	99.3	0.41
	6	46.6 (17.0)	77.8 (21.1)	55.2 (4.9)	179.6	124.4	0.60
	9	35.2 (17.5)	69.9 (17.2)	49.8 (5.4)	154.9	105.1	0.50
Ashed sediments + *Thalassia*	3	19.5 (14.2)	48.0 (19.1)	45.6 (15.2)	113.1	67.5	0.41
	6	35.3 (16.2)	66.4 (18.1)	64.8 (26.3)	166.5	101.7	0.53
	9	47.7 (23.9)	64.5 (8.6)	43.0 (12.4)	155.2	112.2	0.74
Ashed sediments	3	57.6 (20.3)	42.6 (14.2)	65.0 (21.3)	165.2	100.2	1.35
	6	50.1 (6.7)	50.4 (10.0)	58.3 (17.8)	158.8	100.5	0.99
	9	50.4 (10.7)	50.8 (14.6)	45.1 (6.3)	146.3	101.2	0.99

Table 2. Del^{13}C values (ppt_{PDB}) of aquarium treatment water dissolved inorganic carbon (DIC), and Thalassia seedling leaf tissue, and relative isotopic discrimination.

Treatment	Date	pH	$[CO_2]$ (mM)	del^{13}C carbonate	del^{13}C leaf	Del-del
Natural sediments	8/16/88	7.53	2.25	-10.1	- 9.1	1.0
	11/22/88	8.31	1.71	-11.5	-13.3 (1.0)*	- 1.8
	2/23/89	8.31	1.65	-10.6	-16.7 (1.6)	- 6.1
	5/09/89	8.03	2.23	-12.5	-20.1 (1.8)	- 7.6
Peat pellets	8/16/88	8.18	2.18	- 7.0	- 9.1	- 2.1
	11/22/88	8.33	2.00	- 9.8	-13.1 (1.5)	- 3.3
	2/23/89	8.28	2.04	- 9.7	-17.8 (3.2)	- 8.1
	5/09/89	8.09	3.35	- 6.0	-18.3 (1.8)	-12.1
Ashed sediments + CO_2	8/16/88	7.64	2.21	- 8.2**	- 9.1	- 0.9
	11/22/88	7.00	11.11	-11.3**	-24.7 (1.2)	-13.4
	2/23/89	7.10	16.32	-39.9	-50.8 (9.0)	-10.9
	5/09/89	7.97	13.39	-52.8	-57.1	- 4.3
Ashed sediments + Avicennia	8/16/88	8.00	1.99	- 8.8	- 9.1	- 0.3
	11/22/88	8.47	2.94	- 9.2	-13.5 (1.2)	- 4.3
	2/23/89	8.28	1.51	-13.0	-18.8 (2.4)	- 5.8
	5/09/89	8.37	1.78	-15.4	-21.0 (1.3)	- 5.6
Ashed sediments + Thalassia	8/16/88	8.13	2.02	- 9.4	- 9.1	0.3
	11/22/88	8.40	2.11	- 8.4	-11.5 (1.1)	- 3.1
	2/23/89	8.39	2.05	-11.6	-16.6 (3.7)	- 5.0
	5/09/89	8.12	2.68	-13.2	-22.2	- 9.0
Ashed sediments	8/16/88	8.21	1.89	- 9.1	- 9.1	0.0
	11/22/88	8.64	1.65	-11.8	-11.9 (1.4)	- 0.1
	2/23/89	8.24	1.23	- 9.0	-17.2 (1.4)	- 8.2
	5/09/89	8.00	3.12	-11.2	-19.2 (1.7)	- 8.0

*mean (+/- S.D.)
**Value estimated assuming equilibrium with CO_2 gas (del^{13}C= -11.3 ppt) used for bubbling.

Table 3. Biomass (mg dwt) and resource allocation patterns in axen *Thalassia* seedling cultures [mean (+/- S.D.)].

Treatment	Age (months)	Root	Shoot	Seed	Total
Von Stosch					
light	3	1.5	16.0	69.9	87.4
		(3.0)	(13.3)	(40.0)	
	6	5.8	46.1	54.3	106.2
		(7.5)	(12.1)	(20.7)	
dark	3	-	19.8	54.9	74.7
			(9.0)	(17.6)	
	6	0.8	51.2	60.9	113.2
		(1.5)	(16.2)	(22.7)	
VS + 1% sucrose					
light	3	-	13.0	129.9	142.9
			(7.5)	(85.3)	
	6	-	16.3	59.1	75.4
			(5.7)	(22.6)	
dark	3	-	13.0	71.9	84.9
			(2.7)	(33.1)	
	6	-	14.5	48.5	63.0
			(7.0)	(6.2)	
VS + 3% sucrose					
light	3	-	10.7	113.6	124.3
			(4.1)	(37.5)	
	6	-	14.9	54.7	69.6
dark	3	-	14.9	93.5	108.4
			(5.6)	(13.3)	
	6	-	17.2	87.8	105.0
			(1.4)	(34.9)	
VS + 1% *Thalassia* leaves					
light	3	-	31.0	77.4	108.4
			(18.3)	(31.2)	
	6	-	40.8	56.5	97.3
			(25.0)	(30.5)	
dark	3	-	5.0	43.0	48.0
			(3.3)	(20.3)	
	6	-	-	-	-

Table 4. Mean leaf del^{13}C values (+/- S.D.) for axenic <u>Thalassia</u> seedlings after 3 and 6 months in various culture media.

Treatment	del^{13}C (ppt_{PDB}) 3 months	6 months
Von Stosch		
light	- 7.2 (0.8)	- 5.4 (1.2)
dark	- 5.2 (1.2)	- 4.5 (1.7)
VS + 1% Sucrose*		
light	-17.3 (2.8)	-18.0 (1.4)
dark	-15.2 (1.2)	-19.2
VS + 3% Sucrose		
light	-19.7 (1.4)	-21.6
dark	-14.8 (2.5)	-12.5
VS + 1% <u>Thalassia</u>**		
light	- 8.0	-
dark	- 6.7 (0.8)	-
VS + 1% <u>Avicennia</u>***		
light	- 9.4	-
dark	- 6.9	-

*del^{13}C = -24.1
**del^{13}C = -10.0
***del^{13}C = -26.6

References

BENNER, R., FOGEL, M., SPRAGUE, E.K., HODSON, R.E. (1987). Depletion of ^{13}C in lignin and its implications for stable carbon isotope studies. Nature 329:708-710.

BITTAKER, H.F., IVERSON, R.L. (1976). Thalassia testudinum productivity: A field comparison of measurement methods. Mar. Biol. 37:39-46.

DURAKO, M.J., MOFFLER, M.D. (1981). Variation in Thalassia testudinum seedling growth related to geographic origin. pp. 100-117. In: STOVAL, R.H. (ed.): Proc. Eighth Annual Conference on Wetlands Restoration and Creation. Hillsborough Comm. College, Tampa, Florida.

DURAKO, M.J., MOFFLER, M.D. (1987). Nutritional studies of the submerged marine angiosperm Thalassia testudinum. I. Growth responses of axenic seedlings to nitrogen enrichment. Amer. J.Bot. 74:234-240.

FRY, B., MACKO, S.A., ZIEMAN, J.C. (1987). Review of stable isotopic investigations of food webs in seagrass meadows. Pp. 189- 209 In: DURAKO, M.J., PHILLIPS, R.C., LEWIS, R.R. (eds.): Subtropical-Tropical Seagrasses of the Southeastern United States. Fl. Mar. Res. Publ. No. 42. Fla. Dept. Nat. Resour. Bur Mar. Res. St. Petersburg, Florida. 209 pp.

IVERSON, R.L., BITTAKER, H.F. (1986). Seagrass distribution and abundance in eastern Gulf of Mexico coastal waters. Est. Coastal Shelf Sci. 22:577-602.

MCMILLAN, C., SMITH, B.N. (1982). Comparison of del ^{13}C values for seagrasses in experimental cultures and in natural habitats. Aquat. Bot. 14:381-387.

THAYER, G.U., USTACH, J.F. (1981). Gulf of Mexico wetlands: value, state of knowledge, and research needs. Pp. 1-30. In: Proc. Symp. Environ. Res. Needs in the Gulf of Mexico (GOMEX). U.S. Dept. Commerce, Vol. II B.

ZIEMAN, J.C. (1982). The ecology of the seagrasses of south Florida: A community profile. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-82/85. 123 pp.

ZIEMAN, J.C., MACKO, S.A., MILLS, A.L. (1985). Role of seagrasses and mangroves in estuarine food webs: Temporal and spatial changes in stable isotope composition and amino acid content during decomposition. Bull. Mar. Sci. 35:380-392.

TASK IV: PUBLIC INFORMATION ON COASTAL WETLANDS AND CORAL REEFS

Subtask A: Distribution of Estuarine and Coral Reef Brochures

Efforts on Task IV, Subtask A, focused on continuing distribution of the educational brochures on marine habitats. During the period from January 1989 through September 1989, 63,156 brochures were distributed. The totals listed below do not include brochures distributed by laboratory personnel or those taken from our reception area.

Coral Reefs	12,709
Estuaries	13,186
Seagrasses	12,170
Mangroves	13,134
Salt Marsh	11,957
	63,156

WHO TO CONTACT

Brevard County Tourist Development Council
2235 North Courteney Parkway
Merritt Island 32953 305/453-2211
Tourist Development Council
Volusia County
P. O. Box 2775
Daytona Beach 32015
904/255-0981
Cocoa Beach Area C of C*
431 Riveredge Boulevard
Cocoa 32922 305/636-4262
Daytona Beach Area C of C
P. O. Box 2775
Daytona Beach 32015
904/255-0981
Daytona Beach Shores C of C
3616 South Atlantic Ave., Suite A
Daytona Beach Shores 32019
904/761-7163
DeBary Area C of C
P. O. Box 1
DeBary 32713 305/668-4614
DeLand Area C of C
P. O. Box 629
DeLand 32720 904/734-4331
Deltona Area C of C
P. O. Box 152
Deltona 32725 305/668-5522
St. Lucie County C of C
2200 Virginia Avenue
Fort Pierce 33450 305/461-2700
Hobe Sound C of C
P. O. Box 1507
Hobe Sound 33455 305/546-4724
Holly Hill C of C
P. O. Box 615
Holly Hill 32017 904/355-7311
Lake Helen/Cassadaga C of C
P. O. Box 957
Lake Helen 32744 904/228-2932
South Brevard C of C
1005 East Strawbridge Avenue
Melbourne 32901 305/724-5400
New Smyrna/Edgewater C of C
P. O. Box 129
New Smyrna Beach 32069
904/428-2449
Okeechobee County C of C
55 South Parrott Avenue
Okeechobee 33472 813/763-6464
Greater Orange City Area C of C
P. O. Box 752
Orange City 32763 904/775-2793
Ormond Beach C of C
P. O. Box 874
Ormond Beach 32074
904/677-3454
Ormond-By-The-Sea C of C
P. O. Box 3100
Ormond Beach 32074 904/441-2022
Palm Bay Area C of C
P. O. Box 37
Palm Bay 32906 305/723-0799
Palm City C of C
P. O. Box A
Palm City 33490 305/286-8121
Northwest Volusia C of C
P. O. Box 8
Pierson 32080 904/749-2291
Port Orange/South Daytona C of C
1018 Ridgewood Avenue
Port Orange 32019 904/761-1601
Sebastian River Area C of C
P. O. Box 385
Sebastian 32958 305/589-5969
Stuart/Martin County C of C
400 South Federal Highway
Stuart 33497 305/287-1088
Titusville Area C of C
2000 South Washington
Titusville 32780 305/267-3036
Vero Beach C of C
P. O. Box 3947
Vero Beach 32960 305/567-3491
Jensen Beach C of C
1910 Northeast Commercial Street
Jensen Beach 33457 305/334-3444

*Chamber of Commerce

WHO TO CONTACT

Director of Tourism,
Escambia County
1401 E. Gregory Street
Pensacola 32501 904/434-1234
Bay County Tourist Development Council
Post Office Box 9416
Panama City 3240 904/235-2636
Emerald Coast Tourist Development Council
P. O. Box 4204
Fort Walton Beach 32549-4204
Apalachicola Bay C of C*
45 Market Street
Apalachicola 32320 904/654-9419
Calhoun County C of C
425 East Central Avenue, Room 127
Blountstown 32424 904/674-4519
Holmes County C of C
P. O. Box 1977
Bonifay 32425 904/547-4682
Levy County C of C
P. O. Box 118
Cedar Key 32625 904/543-5410
Liberty County C of C
P. O. Box 526
Bristol 32321 904/643-2442
Washington County C of C
P. O. Box 457
Chipley 32428 904/638-4157
Wakulla County C of C
P. O. Box 598
Crawfordville 32327 904/926-7849
Crestview Area C of C
502 South Main Street
Crestview 32536 904/682-3212
Dixie County C of C
P. O. Box 547
Cross City 32628 904/498-5181
Walton County C of C
P. O. Box 29
DeFuniak Springs 32433
904/892-3191
Destin C of C
P. O. Box 8
Destin 32541 904/837-6241
Greater Fort Walton Beach C of C
P. O. Drawer 640
Fort Walton Beach 32548
904/244-8191
Greater Gulf Breeze C of C
P. O. Box 337
Gulf Breeze 32561 904/932-7888

Greater Madison C of C
105 North Range Street
Madison 32340 904/973-2788
Jackson County C of C
P. O. Box 130
Marianna 32446 904/482-8061
Lafayette County C of C
P. O. Box 416
Mayo 32066 904/294-2705
Santa Rosa County C of C
501 Stewart Street, SW
Milton 32570 904/623-2339
Monticello-Jefferson County C of C
420 West Washington Street
Monticello 32344 904/997-5552
Bay County C of C
P. O. Box 1850
Panama City 32401 904/785-5206
Pensacola Area C of C
P. O. Box 550
Pensacola 32593 904/438-4081
Perry-Taylor County C of C
P. O. Box 892
Perry 32347 904/584-5366
Port St. Joe & Gulf County C of C
P. O. Box 964
Port St. Joe 32456 904/227-1223
Gadsden County C of C
P. O. Box 389
Quincy 32351 904/627-9231
Tallahassee C of C
P. O. Box 1639
Tallahassee 32302 904/224-8116
Gilchrist County C of C
P. O. Box 186
Trenton 32693 904/463-6327
Niceville-Valparaiso Bay Area C of C
179 John Sims Parkway
Valparaiso 32580 904/678-2323

*Chamber of Commerce

WHO TO CONTACT

Jacksonville Convention & Visitor's Bureau
33 Hogan Street, Suite 250
Jacksonville 32202 904/353-9736
Alachua C of C*
P. O. Box 387
Alachua 32615 904/462-3333
West Nassau County C of C
P. O. Box 98
Callahan 32011 904/879-1441
Amelia Island/Fernandina Beach C of C
P. O. Box 472
Fernandina Beach 32034 904/261-3248
Flagler County C of C
P. O. Box 689
Flagler Beach 32036 904/439-2943
Gainesville Area C of C
P. O. Box 1187
Gainesville 32602 904/372-4305
Hawthorne Area C of C
P. O. Box 1236
Hawthorne 32640 904/481-3314
High Springs C of C
P. O. Box 385
High Springs 32643 904/454-1067
Jacksonville Area C of C
P. O. Box 329
Jacksonville 32201 904/353-0300
Jacksonville Beaches Area C of C
P. O. Box 50427
Jacksonville Beach 32250 904/249-3868
Hamilton County C of C
P. O. Drawer P
Jasper 32052 904/792-1300
Lake City/Columbia County C of C
P. O. Box 566
Lake City 32055 904/752-3690
Suwannee County C of C
P. O. Box C
Live Oak 32060 904/362-3071
Baker County C of C
P. O. Box 587
Macclenny 32063 904/259-6433
Newberry Area C of C
P. O. Box 1004
Newberry 32669 904/472-4121
Clay County C of C
P. O. Box 1441
Orange Park 32073 904/264-2651
Putnam County C of C
P. O. Box 550
Palatka 32077 904/328-1503
St. Augustine & St. Johns County C of C
P. O. Box O
St. Augustine 32085 904/829-5681
Starke/Bradford County C of C
P. O. Box 1116
Starke 32091 904/964-5278

*Chamber of Commerce

WHO TO CONTACT

Tourist Development Council
Broward County
201 S.E. Eighth Avenue
Fort Lauderdale, FL 33301
305/765-5508

Tourist Development Council
Monroe County
Box 866
Key West, FL 33041 305/296-2228

Tourist Development Council
Dade County
555 17th Street
Miami FL 33139
305/673-7070

Tourist Development Council
Palm Beach County
1555 Palm Beach Lakes Blvd.
Suite 204
West Palm Beach, FL 33401
305/471-3995

Belle Glade C of C*
540 South Main Street
Belle Glade 33430 305/996-2745

Lower Keys C of C
P. O. Box 511
Big Pine Key 33043 305/872-2411

Greater Boca Raton C of C
P. O. Box 1390
Boca Raton 33432 305/395-4433

Greater Boynton Beach C of C
639 Ocean Avenue, Unit 108
Boynton Beach 33435
305/732-9501

Clewiston C of C
P. O. Box 275
Clewiston 33440 813/983-7979

Coconut Grove C of C
3437 Main Highway
Coconut Grove 33133
305/444-7270

Coral Gables C of C
50 Aragon Avenue
Coral Gables 33134 305/446-1657

Coral Springs C of C
9767 West Sample Road
Coral Springs 33065 305/752-4242

Dania C of C
P. O. Box 838
Dania 33004 305/927-3377

Davie/Cooper City C of C
4185 Southwest 64th Avenue
Davie 33314 305/581-0790

Deerfield Beach C of C
1601 East Hillsboro Boulevard
Deerfield Beach 33441
305/427-1050

Greater Delray Beach C of C
64 Southeast Fifth Avenue
Delray Beach 33444 305/278-0424

Fort Lauderdale/Broward County C of C
P. O. Box 14516
Fort Lauderdale 33302
305/462-6000

Hallandale C of C
P. O. Box 249
Hallandale 33009 305/454-0541

Hialeah/Miami Springs Area C of C
59 West Fifth Street
Hialeah 33010 305/887-1515

Greater Hollywood C of C
P. O. Box 2345
Hollywood 33022 305/920-3330

Greater Homestead/Florida City C of C
650 U. S. Highway 1
Homestead 33030 305/247-2332

Islamorada C of C
P. O. Box 915
Islamorada 33036 305/664-4503

Jupiter/Tequesta C of C
P. O. Box 817
Jupiter 33458 305/746-7111

Key Biscayne C of C
95 West McIntyre Street
Key Biscayne 33149 305/361-5207

Key Colony Beach C of C
P. O. Box 89
Key Colony Beach 33051
305/289-1212

Florida Upper Keys C of C
P. O. Box 274-C
Key Largo 33037 305/451-1414

Greater Key West C of C
402 Wall Street
Key West 33040 305/294-2587

Greater Lake Worth C of C
1702 Lake Worth Road
Lake Worth 33460 305/582-4401

Greater Lantana C of C
212 Iris Street
Lantana 33462 305/585-8664

Greater Marathon C of C
3330 Overseas Highway
Marathon 33050 305/743-5417

Tri-City C of C
6130 West Atlantic Boulevard
Margate 33063 305/972-0818

Greater Miami C of C
1601 Biscayne Boulevard
Omni Complex, Seventh Floor
Miami 33132 305/350-7700

North Dade C of C
P. O. Box 693116
Miami 33169 305/652-3371

South Dade C of C
900 Perrine Avenue
Miami 33157 305/238-7192

Latin C of C
P. O. Box 350824
Miami 33135 305/642-3870

Miami-Dade C of C
6255 Northwest Seventh Avenue
Miami 33150 305/751-8648

Miami Beach C of C
1920 Meridian Avenue
Miami Beach 33139 305/672-1270

Miami Shores C of C
9523 Northeast Second Avenue
Miami Shores 33138 305/754-5466

Northwest Dade County C of C
45 Curtiss Parkway
Miami Springs 33166 305/822-1911

Miramar/Pembroke C of C
7156 Pembroke Road
Miramar 33023 305/961-4500

Glades County C of C
P. O. Box 490
Moore Haven 33471 813/946-2392

North Miami C of C
13100 West Dixie Highway
North Miami 33161 305/891-7811

North Miami Beach C of C
39 Northeast 167th Street
North Miami Beach 33162
305/653-1200

Opa-locka C of C
P. O. Box 1014
Opa-locka 33054 305/681-7011

Pahokee C of C
115 East Main Street
Pahokee 33476 305/924-5579

Palm Beach C of C
45 Coconut Row
Palm Beach 33480 305/655-3282

Greater Plantation C of C
7401 Northwest Fourth Street
Plantation 33317 305/587-1410

Greater Pompano Beach C of C
2200 East Atlantic Boulevard
Pompano Beach 33062
305/941-2940

Northern Palm Beach County C of C
3601 Broadway
Riviera Beach 33404 305/848-3431

South Miami/Kendall Area C of C
P. O. Box 430585
South Miami 33143 305/661-1621

Sunrise C of C
3122 North Pine Island Road
Sunrise 33321 305/741-3300

Florida Gold Coast C of C
P. O. Box 6572
Surfside 33154 305/866-6020

Greater West Palm Beach C of C
P. O. Box 2931
West Palm Beach 33402
305/833-3711

Greater LaBelle C of C
P.O. Box 456
LaBelle 33935 813/675-0125

*Chamber of Commerce

WHO TO CONTACT

Tourist Development Council
Manatee County
P.O. Box 321
Bradenton 33506 813/722-3900
Tourist Development Council
Charlotte County
P.O. Box 1398
Englewood 33533 813/474-7713
Tourist Development Council
Lee County
P.O. Box 2445
Fort Myers 33902-9990
813/335-2631
DeSoto County C of C*
P.O. Box 149
Arcadia 33821 813/494-4033
Bonita Springs Area C of C
P.O. Box 104
Bonita Springs 33923
813/992-2943
Cape Coral C of C
2051 Cape Coral Parkway
Cape Coral 33904 305/542-3721
Greater Pine Island C of C
P.O. Box 525
Matlacha 33909 813/283-0888
Englewood Area C of C
601 South Indiana Avenue
Englewood 33533 813/474-5511
Everglades Area C of C
P.O. Box E
Everglades City 33929
813/695-3941
Metropolitan Fort Myers C of C
P.O. Box CC
Fort Myers 33902 813/334-1133
Fort Myers Beach C of C
P.O. Box 6109
Fort Myers Beach 33931
813/463-6451
Immokalee C of C
P.O. Drawer C
Immokalee 33934 813/657-3237
Lehigh Acres C of C
P.O. Box 757
Lehigh Acres 33936 813/369-3322
Marco Island C of C
P.O. Box 913
Marco Island 33937 813/394-7549
Naples Area C of C
1700 North Tamiami Trail
Naples 33940 813/262-6141
Charlotte County C of C
P.O. 2702 Tamiami Trail
Port Charlotte 33952 813/627-2222
Sanibel-Captiva Islands C of C
Causeway Road
Sanibel Island 33957 813/472-1080

*Chamber of Commerce

WHO TO CONTACT

Citrus County Commission and Tourist Development Council
110 North Apopka Street
Inverness 32650 904/726-8500
Tourist Development Council
Pinellas County
Newport Square #109A
2333 East Bay Drive
Clearwater 33546 813/530-6452
Greater Sarasota Tourism Association
655 North Tamiami
Sarasota 33577 813/957-1877
Tampa/Hillsborough County Convention & Visitors Bureau
100 South Ashley Drive,
Suite 850
Tampa 33601 813/223-1111
Manatee C of C
P.O. Box 321
Bradenton 33506 813/748-3411
Anna Maria Island C of C
P.O. Box 336
Bradenton Beach 33510
813/778-1003
Greater Brandon C of C
408 West Brandon Boulevard
Brandon 33511 813/689-1221
Hernando County C of C
101 East Fort Dade Avenue
Brooksville 33512 904/796-2420
Greater Clearwater C of C
P.O. Box 2457
Clearwater 33517 813/461-0011
Pinellas Suncoast C of C
St. Petersburg/Clearwater Airport,
Suite 239
Clearwater 33520 813/531-4657
Citrus County Suncoast C of C
City/County Building
Crystal River 32629 904/795-3149
Greater Dade City C of C
Meridian at Seventh Street
Dade City 33525 904/567-3769
Greater Dunedin C of C
434 Main Street
Dunedin 33528 813/736-5066
Homosassa Springs Area C of C
P.O. Box 1098
Homosassa Springs 32647
904/628-2666
Greater Hudson Area C of C
13740 Old Dixie Highway
Hudson 33567 813/868-9395
Holiday Isles C of C
P.O. Box 273
Indian Rocks Beach 33535
813/595-4575
Land O'Lakes C of C
P.O. Box 98
Land O'Lakes 33539 813/996-6470
Greater Largo C of C
P.O. Box 326
Largo 33540 813/584-2321
Longboat Key C of C
510 Bay Isles Road
Longboat Key 33548
813/383-1212
Madeira Beach C of C
501 150th Avenue
Madeira Beach 33708
813/391-7373
West Pasco C of C
407 West Main Street
New Port Richey 33552
813/842-7651
Oldsmar C of C
P.O. Box 521
Oldsmar 33557 813/536-5988
Greater Palm Harbor Area C of C
1000 North U.S. 19 #300
Palm State Bank Building
Palm Harbor 33563 813/784-4287
Pinellas Park C of C
5851 Park Boulevard
Pinellas Park 33565 813/544-4777
Greater Plant City C of C
P.O. Drawer CC
Plant City 33566 813/754-3707
South Hillsborough County C of C
315 U.S. Highway 41, South
Ruskin 33570 813/645-3808
Safety Harbor C of C
200 Main Street
Safety Harbor 33572 813/726-2890
St. Petersburg Area C of C
P.O. Box 1371
St. Petersburg 33731
813/821-4069
St. Petersburg Beach Area C of C
P.O. Box 66375
St. Petersburg Beach 33736
813/360-6957
Sarasota County C of C
P.O. Box 308
Sarasota 33578 813/955-8187
Siesta Key C of C
P.O. Box 5188
Sarasota 33579 813/924-9696
Greater Seminole Area C of C
P.O. Box 3337
Seminole 33542 813/392-3245
Sun City Center C of C
P.O. Box 5203
Sun City Center 33571 813/634-5111
Greater Tampa C of C
P.O. Box 420
Tampa 33601 813/228-7777
North Tampa C of C
P.O. Box 8247
Tampa 33674 813/935-7200
West Tampa C of C
3005 West Columbus Drive
Tampa 33607
Ybor City 1513 Eighth Avenue
Tampa 33605 813/248-3712
Greater Tarpon Springs C of C
528 East Tarpon Avenue
Tarpon Springs Avenue
Tarpon Springs 335589 813 937-6109
Thonotosassa C of C
105 Main Street
Thonotosassa 33592 813/986-4241
Treasure Island C of C
P.O. Box 9284
Treasure Island 33706 813/360-1741
Women's C of C of the Greater Gulf Beaches
P.O. Box 9206
Treasure Island 33706
813/392-4968
Venice Area C of C
257 North Tamiami Trail
Venice 33595 813/488-2236
Zephrhills C of C
691 Fifth Avenue
Zephyrhills 33599 813/782-1913

WHO TO CONTACT

Tourist Development Council
Orange County
7680 Republic Drive, Suite 200
Orlando 32819 305/345-8882
Kissimmee/St. Cloud Convention & Visitors Bureau
P. O. Box 2007
Kissimmee 32742 305/847-5000
Greater Seminole County C of C*
P. O. Box 784
Altamonte Springs 32701
305/834-4404
Apopka Area C of C
180 East Main Street
Apopka 32703 305/886-1441
Auburndale C of C
111 East Park Street
Auburndale 33823 813/967-3400
Avon Park C of C
P. O. Box 1330
Avon Park 33825 813/453-3350
Greater Bartow C of C
P. O. Box 956
Bartow 33830 813/533-7125
Belleview/South Marion C of C
P. O. Box 602
Belleview 32620 904/245-2178
Sumter County C of C
P. O. Box 158
Bushnell 33513 904/793-3099
Clermont C of C
P. O. Box 417
Clermont 32711 904/394-4191
Dunnellon Area C of C
P. O. Box 868
Dunnellon 32630 904/489-2320
Eagle Lake C of C
P. O. Box 884
Eagle Lake 33839
Eustis C of C
P. O. Box 1210
Eustis 32726 904/357-3434
Lake County C of C
P. O. Drawer AZ
Eustis 32726 904/728-4955
Fort Meade C of C
P. O. Box 91
Fort Meade 33841 813/285-8253
Frostproof C of C
P. O. Box 968
Frostproof 33843 813/635-4066

Groveland/Mascotte C of C
P. O. Box 115
Groveland 32736 904/429-3678
Greater Haines City C of C
P. O. Box 986
Haines City 33844 813/422-3751
Kissimmee/Osceola County C of C
P. O. Box 1982
Kissimmee 32741 305/847-3174
Lake Alfred C of C
P. O. Box 956
Lake Alfred 33850 813/956-1334
Greater Lake Placid C of C
P. O. Box 187
Lake Placid 33852 813/465-4331
Greater Lake Wales C of C
P. O. Box 191
Lake Wales 33853 813/676-3445
Lakeland Area C of C
P. O. Box 3538
Lakeland 33802 813/688-8551
Leesburg Area C of C
P. O. Box 269
Leesburg 32748 904/787-2131
Longwood/Winter Springs C of C
P. O. Box 963
Longwood 32750 305/831-9991
Maitland/South Seminole C of C
110 North Maitland Avenue
Maitland 32751 305/644-0741
Mount Dora C of C
P. O. Box 196
Mount Dora 32757 904/383-2165
Greater Mulberry C of C
P. O. Box 254
Mulberry 33860 813/425-1125
Ocala/Marion County C of C
P. O. Box 1210
Ocala 32678 904/629-8051
Orlando Area C of C
P. O. Box 1234
Orlando 32802 305/425-1234
St. Cloud Area C of C
P. O. Box 5
St. Cloud 32769 305/892-3671
Greater Sanford C of C
P. O. Drawer CC
Sanford 32771 305/322-2212
Greater Sebring C of C
309 South Circle
Sebring 33870 813/385-8448

Tavares C of C
P. O. Box 697
Tavares 32778 904/343-2531
Umatilla C of C
P. O. Box 300
Umatilla 32784 904/669-3511
East Orange C of C
P. O. Box 9080
Union Park 32817 305/277-5951
Wauchula/Hardee County C of C
P. O. Box 683
Wauchula 33873 813/773-6967
Wildwood Area C of C
P. O. Box 1179
Wildwood 32785 904/748-2221
West Orange C of C
P. O. Box 522
Winter Garden 32787 305/656-1304
Winter Haven Area C of C
P. O. Box 1420
Winter Haven 33880 813/293-2138
Winter Park C of C
P. O. Box 280
Winter Park 32790 305/644-8281

*Chamber of Commerce

No zips

04/07/88

List for E & I letters

Name	Title	Organization	Address		City
Mrs. Donna Strickland	Supervisor of Science	Dept. Education, Environmental Education	620 E. University Ave.		Gainesville ,
Mrs Burney Winkler	Dir.of Curriculum K-12	FL Dept. Education, Environmental Education	582 North Temple Ave		Starke
Mr. Jerry Edgar	Director,Vocational Education	FL Dept. Education, Environmental Education	425 E. Central Ave. G-20		Blountstown ,
Dr. Richard Crump	Supervisor, Secondary	FL Dept of Education, Environmental Education	900 Walnut Street		Green Cove Spring
Dr. James Yopp	Director of Elementary Education	FL. Dept. Education, Environmental Education	Rt.#7, Box 541		Lake City
Dr. Ronnie D. Kirkland	Director of Secondary Education	FL Dept.Education, Environmental Education	392 South Blvd. East		Macclenny
Mr.Dave Howell	Science Resource Teacher	FL Dept. Education, Environmental education	1274 south Florida Ave.		Rockledge
Mr. Alton Cheatham		FL Dept Education, Environmental Education	Peace River Elementary School	22400 Hancock Ave.	Charlotte Harbor
Mrs Nancy Leaderer	Supervisor, Elementary Curriculum	Fl.Dept. Education, Environmental Education	1532 Kingsley Ave., Suite 110		Orange Park
Dr. Mildred Berry	Supervisor, Science	FL Dept.Education, Environemntal Eduction	1450 N.E. 2nd Ave. Room 918		Miami
Mr. Curtis Scott	Program Specialist	FL Dept.Education,Environmental Education	P.O. Drawer 820		Panama City
Mrs. Angie Matamoros	Curriculum Cluster Supervsr.Sci/Hlt	FL Dept. Education, Environmental Education	6650 Griffin Road		Ft.Lauderdale
Mrs. Roberta Dilocker	Coordinator,Math & Science	FL Dept. Education, Environmental Education	1007 West Main St.		Inverness
Dr. Haydee Navarro	Director of Instruction	FL Dept. Education, Environmental Education	3710 Estey Ave		Naples
Mr. William Stanko	Head Teacher,Environmental Lab	Fl Dept. Education, Environmental Education	530 La Solona Ave		Arcadia
Mrs.Paula Whittier	Deputy Supt. for Instruction	FL Dept. Education, Environmental Education	P.O. Box 3-E		Cross City
Dr. Richard Conkling	Coordinator for Curriculum	FL Dept. Education, Environmental Education	P.O. Box 755		Bunnell

List for E & I letters

Name	Title	Organization	Address	City
Mr. Harrison Schofield	Director of Projects	FL Dept. Education, Environmental Education	P.O. Box 67	Trenton
Ms.Lillian Sasnett	Director of Instructional Services	FL Dept. Education, Environmental Education	P.O. Box 1059	Jasper
Mr. Martin Yungman	District Director of Curriculum	FL Dept.Education,Environmental Education	919 U.S. 41 North	Brooksville
Dr. Jed Klein	Director Instruction	FL Dept Education, Environmental Education	1701 Prudential Drive	Jacksonville
Mr. C.T. Ponder	Secondary Administration	FL Dept. Education, Environmental Education	155 Ave E	Apalachicola
Mr. George Steele	Director of Administrative Services	FL Dept.Education, Environmental Education	P.O. Box 459	Moore Haven
Mr John Masterson	Director of Curriculum 6-12	FL Dept. Education, Environmental Education	P.O. Drawer 1679	Wauchula
Mr. Dewayne Lemler	Coordinator, Secondary Education	FL Dept Education, Environmental Education	426 School Street	Sebring
Mr.Roy Hyatt	Dir./Environmental Sensitivity Proj	FL Dept Education,Environmental Education	P.O. Box 636	Gonzalez
Mrs. Mary Baker	Chapter 1, Program Supervisor	FL Dept. Education, Environmental Education	P.O. Box 818	Quincy
Mrs. Barbara Shirley-Scott	Director of Instructional Service	FL Dept Education, Environmental Education	Gulf County Courthouse	Port St. JOe
Mr. Kenneth Dooley	Asst.Supervisor for Instruction	FL Dept Education,Environmental Education	P.O. Box 1980	Labelle
Mr. Michael Mullins	Coord.of EnvironmentalEd.	FL Dept Education, Environmental Education	P.O. Box 3408	Tampa
Mrs. Jean West	Special Programs Administrator	FL Dept Education, Environmental Education	211 W. Iowa Ave	Bonifay
Mrs. Dorothy Bishop	Dir.Instructional Services&Staff	Fl Dept.Education, Environmental Education	1490 W.Washington Street	Monticello
Mr.R. William Hammond	Dir. Environmental Ed.,Instr.Serv.		Nature Center, Ortiz Ave	Ft. Myers
Mrs. Shirley Bateman	Dir. of Instruction	FL Dept Education, Environmental Education	P.O. Box 429	Bristol

List for E & I letters

Name	Title	Organization	Address	City
Mr. Wiley C. Kerlin	Dir. Secondary Education	FL Dept. Education, Environmental Education	P.O. Box 570	Ocala
Dr. A.Ronald Hudson	Asst Super. Instruction	FL Dept. Education, Environmental Education	1990 25th Street	Vero Beach
Mrs. Dolores H. Ceraso	Administrative Asst. for Programs	FL Dept Education, Environmental Education	P.O. Box 58	Mayo
Mrs.Mildred Hall	Secondary Science Curr.Team	FL Dept. Education, Environmental 'Education	2757 West Pensacola Street	Tallahassee
Mr. James Ray	Dir of Personnel and Sec.Educ.	FL Dept Education, Environmental Education	P.O. Box 449	Madison
Dr. Barbara Anderson	Dir. Ele. Education	Fl Dept. Education, Environmental Education	500 East Ocean Blvd.	Stuart
Mr. Thomas L. Melvin	~~Dir.,~~ Vocational Education	FL Dept Education, Environmental Education	P.O. Box 5958	Marianna
Mrs.Beverly Haskins	Super. Secondary Education	FL Dept Education, Environmental Education	201 Burleigh Blvd	Tavares
Mr. Paul D. Johnson	Asst. Supt. Instruc. Services	Fl Dept Education, Environmental Education	P.O. Drawer 129	Bronson
Mr. Robert Kitzmiller	Supervisor of Science	Fl Dept Education, Environmental Education	P.O. Box 9069	Bradenton
Mrs. Betty Cox	Director of Secondary Education	Fl Dept Education, Environmental Education	500 East Ocean blvd.	Stuart
Mrs. Betty Cox	Specialist	Fl Dept. Education, Environmental Education	242 White St. P.O. box 1788	Key West
Miss Sharon Suits	Science Education Contact	FL Dept. Education, Environmental Education	100 S.W. Fifth Ave.	Okeechobee
Dr. R. Camille Dorman	Asst. Super. Instruction	Fl Dept. Education, Environmental Education	P.O. box 24690	West Palm Beach
Mr. Dick Mullenax	Science Supervisor	Fl. Dept Education, Environmental Education	P.O. box 391	Bartow
Mr. Jack Roberts	Super.,Media,Career, Consumer Ed.	Fl Dept Education, Environmental Education	310 Preston Court	Ft. Pierce
Mrs. Leona Davis	Dir. Secondary Education	Fl Dept Education, Dept. Environmental Education	1201 Atlantic Ave	Fernandina Beach

List for E & I letters

Name	Title	Organization	Address	City
Ms. Arlene Bridges	Program Consultant, Ele. Science	Fl Dept Education, Environmental Education	P.O. Box 271	Orlando
Mr. Steven Rinck	Supervisor Science	Fl Dept Education, Environmental Education	7227 U.S. Highway 41	Land O'Lakes
Mrs. Meredith M.Barker	Dir. Middle School Ed.Services	Fl Dept. Education, Environmental Education	200 S. 7th Street	Palatka
Mr. Micky Walker	Coord. Math and Science	Fl Dept Education, Environmental Education	603 Canal Street	Milton
Mr. Joe W. Stanton	Science Super. Secondary Accredit.	Fl Dept Education, Environmental Education	120 Lowery Place	Ft. Walton Beach
Mr. Blaine Muse	Dir.Middle School and Sec. Ed	FlDept. Education,Environmental Education	P.O. Box 1948	Kissimmee
Mr. Thomas M. Baird	Dir., ~~K-12~~ Science	Fl Dept Education, Environmental Education	205 4th St. S.W.	Largo
Dr. Sandra McDonald	Dir. Curric. and Instruction	Fl Dept Education, Environmental Education	40 Orange Street	St. Augustine
Mr. Richard Codispoti	Super. Science Education	Fl Dept Education, Environmental Education	2418 Hatton Street	Sarasota
Mrs. Bettie Palmer	Consultant/Coor of Science	Fl Dept Education, Environmental Education	1211 Mellonville Ave	Sanford
Mr. Lawrence Hughes, Jr	Instructional Coord.	Fl Dept Education, Environmental Education	502 North Center Street	Perry
Ms. Sue Keel	Coord. Special Programs	Fl Dept Education,Environmental Education	P.O. Box 100	Crawfordville
Mr. Larry D. Ross	Instructional Supervisor	Fl Dept Education, Environmental Education	202 N Florida Street	Bushnell
Mr. Howard McNeill	Asst. Super. for Instruction	Fl Dept Education, Environmental Education	55 S.W. 6th Street	Lake Butler
Mr. James King	Director of Instruction	Fl Dept Education, Environmental Education	Park Ave	Defuniak Springs
Mr. Marvin Johns	Director of Instruction	Fl Dept Education, Environmental Education	224 West Parshley Street	Live Oak
Ms. Billie Wisniewski	Science Supervisor	Fl Dept Education, Environmental Education	P.O. Box 1910	Daytona Beach

List for E & I letters

me	Title	Organization	Address		City
.. Pat Williams	Director of Instruction	Fl Dept Education, Environmental Education	206 North Third Street		Chipley
ay County Public Library		Florida State Library Depositories	25 West Government Street		Panama City
Vista Campus Library		Florida State Library Depositories	Documents Department	Florida International University	North Miami
ward County Div. of raries		Florida State Library Depositories	100 South Andrews Ave.		Fort Lauderdale
Cocoa Public Library		Florida State Library Depositories	430 Delannoy Ave		Cocoa
orida Atlantic niversity Library		Florida State Library Depositories	P.O. Box 3092		Boca Raton
Florida International iv.		Florida State Library Depositories	Documents Section	Tamiami Campus Library-Tamiami Trail	Miami,
Florida State University brary		Florida State Depositories	Documents -Maps Division		Tallahassee
cksonville Public Library		Florida State Library Depositories	122 North Ocean Street		Jacksonvill e
iami Beach Public ibrary		Florida State Library Depositories	2100 Collins Ave.		Miami Beach
iami Dade Public Library		Florida State Library Depositories	101 West Flagler		Miami
cala Public Library		Florida State Library Depositories	15 Southeast Osceola Ave.		Ocala
Orange County Library District		Florida State Library Depositories	101 East Central		Orlando
St. Petersburg Public Library		Florida State Library Depositories	3745 Ninth Ave North		St. Petersburg
State Library of Florida		Florida State Library Depositories	Document Section	R.A. Gray Building	Tallahassee
Stetson University		Florida State Library Depositories	Dupont-Ball Library		Deland
Jacksonville University		Florida State Library Depositories	Carl S. Swisher Library	University Blvd. North	Jacksonvill e
Tampa-Hillsborough County Lib. Sys.		Florida State Library Depositories	900 North Ashley		Tampa
University of Central Florida Libry		Florida State Library Depositories	P.O. Box 25000		Orlando
University of Florida Library		Florida State Library Depositories	Documents Department		Gainesville
University of Miami Library		Florida State Library Depositories	Gov't Publications	P.O. 249214	Coral Gables
University North Florida Library		Florida State Library Depositories	Documents Division	P.O. Box 17605	Jacksonvill e
University of South Florida		Florida State Depositories	Library-Special Collections	4204 Fowler Ave	Tampa
University West Florida		Florida State Library Depositories	Documents-John Pace Library		Pensacola

List for E & I letters

Name	Title	Organization	Address	City
West Palm Beach Public Library		Florida State Library Depositories	100 Clematis	West Palm Beach
Anastasia State Rec. Area		Fl. DNR Div Rec & Parks, Park Service	5 Anastasia Park Drive	St. Augustine
Apalachicola River & Bay Natl Sanc.		FDNR Div Rec & Parks, Fl Park Service	261 Seventh Street	Apalachicola
Bahia Honda State Rec. Area		FDNR Div Rec & Parks Park Service	Rt. 1 Box 782	Big Pine Key
Big Lagoon State Recreation Area		FDNR Div Rec and Parks Park Service	12301 Gulf Beach Highway	Pensacola
Bill Baggs Cape Fl. State Rec. Area		FDNR Div. Parks and Rec. Park Service	1200 S. Crandon Blvd	Key Biscayne
Bulow Plantation Ruins State Hist.	Ranger	FDNR Div. Parks and Rec. Park Service	P.O. Box 655	Bunnell
Caladesi Island State Park		FDNR Div Parks and Rec Park Service	No 1 Causeway Blvd	Dunedin
Cape St. George State Reserve	Ranger	FDNR Div Parks and Rec, Park Service	261 Seventh Street	Apalachicola
Cedar Key State Museum		FDNR Div Rec.and Parks/Park Service	P.O. Box 538	Cedar Key
Cayo Costa State Park		FDNR Div of Rec and Parks/Park Service	P.O. Box 1150	Boca Grande
Charlotte Harbor State Reserve		FDNR Div Rec and Parks/Park Service	P.O. 591	Bokeelia
Chekika State Recreation Area		FDNR Div Rec and Parks/ Park Service	P.O. Box 1313	Homestead
Collier Seminole State Park		FDNR Div Rec and Parks/Park Service	Marco	
Constitution Convention StateMuseum	Ranger	FDNR Div Rec and Parks/Park Service	200 Allen Memorial Way	Port St. Joe
Crystal River State Arch. Site		FDNR Div Rec and Parks/Park Service	3400 N. Museum Pt.	Crystal River
Delnor Wiggins Pass State rec. Area			11100 Gulf Shore Dr. N	Naples
Dr. Julian Bruce/St. George Island			P.O. Box 62	Eastpoint
Eden State Gardens			P.O. box 26	Point Washington
Fakahatchee Strand State Preserve			P.O. Box 548	Copeland
Faver-Dykes State Park			Rt.4 Box 213-J-1	St. Augustine
Flagler Beach State Rec Area			3100 South A1A	Flagler Beach
Fort Clinch State Park			2601 Atlantic Ave	Fernandina Beach
Ft. Pierce Inlet State Rec. Area			200 Atlantic Beach Blvd	Ft. Pierce
Ft. Zachary Tayor State Hist. Site			P.O. Box 289	Key West

List for E & I letters

Name	Title	Organization	Address	City
Fred Gannon Rocky Bayou Rec. Area..			Rt. 1 box 597	Niceville
Grayton Beach State Rec Area			P.O. Box 1062	Santa Rosa Beach
Hillsborough River State Park			15402 U.S. 301 North	Thonotosass a
Honeymoon Island State Rec Area			No 1 Causeway Blvd	Dunedin
Hugh Taylor Birch State Rec Area			3109 East Sunrise Blvd	Ft Lauderdale
John D. McArthur Beach State Park			10900 S.R. 703	North Palm Beach
John Pennecamp Coral Reef State Prk			P.O. Box 487	Key Largo
John Lloyd Beach State Rec Area	Mr.		6503 North Ocean Dr	Dania
Gamble Plantation Hist Site			3708 Patten Ave	Ellenton
Kingsley Plantation Hist Site			P.O. Box 321	Fort George
Key Largo Coral Reef Nat'l Sanctuar			P.O. Box 1083	Key Largo
Koreshan State Historic Site			P.O. Box 7	Estero
Lignumvitae Key State Botanical Ste			P.O. Box 1052	Islamorada
Little Talbot Island State Park			12157 Heckscher Drive	Fort George
Looe Key State Rec Area			Route 1 Box 782	Big Pine Key
Manatee Springs State Park			Rt.2 Box 617	Chiefland
Myakka River State Park			13207 S.R. 72	Sarasota
New Smyrna Sugar Mills Hist. Site	Ranger		P.O. Box 861	New Smyrna Beach
Ochlocknee River State Park			P.O. Box 5	Sopchoppy
Oleta River State Rec Area			P.O. Box 601305	North Miami
Oscar Scherer State Rec Area			P.O. Box 398	Osprey
Pahokee State Rec Area			P.O. Drawer 719	Pahokee
St. Andrews State Rec Area			4415 Thomas Drive	Panama City
San Marcos de Apalache State Site			P.O. Box 27	St. Marks
Sebastian Inlet State Rec. Area			9700 South A1A	Melbourne Beach
St. Joseph Peninsula State Park			Star Route 1, Box 200	Port St. Joe
Tomoka State Park			2099 North Beach Street	Ormond Beach

List for E & I letters

Name	Title	Organization	Address	City
Waccasassa Bay State Preserve			P.O. Box 187	Cedar Key
Washington Oaks State Gardens			Rte 1, Box 128-A	St. Augustine
Weedon Island State Preserve			1500 Weedon Island Drive	St. Petersburg
Glavis Tiller, Jr.	District Manager		4415 Thomas Drive	Panama City
Johnny Johnston	District Manager		3540 Thomasville Road	Tallahassee
William Perry	District Manager		4801 S.E. 17th Street	Gainesville
Gilbert Becker	District Manager		2099 North Beach Street	Ormond Beach
Torrey Johnson	District Manager		Rt. 1 Box 107-AA	Clermont
John Ernst	District Manager		P.O. Box 398	Osprey
Richard Domroski	District Manager		P.O. Box 8	Hobe Sound
Michael Murphy	District Manager		P.O. box 2660	Key Largo
Arnold Kuenzler	District Manager		1800 Wekiva Circle	Apopka
Russell Danser		Historic & Environmental Land Management	3900 Commonwealth Blvd	Tallahassee
Long Key State Rec Area			P.O. Box 776	Long Key
Jamie L. Serino	Information Specialist III	Bureau of Marine Research	100 Second Ave South	St. Petersburg,
	Director of Tourism	Escambia County	1401 E Gregory St	Pensacola
		Bay Cty Tourist Development Council	P.O. Box 9416	Panama City
		Emerald Coast Tourist Development Council	P.O. Box 4204	Fort Walton Beach
		Apalachicola Bay Chamber of Commerce	45 Market Street	Apalachicola
		Levy County Chamber of Commerce	P.O. Box 118	Cedar Key
		Liberty County Chamber of Commerce	P.O. 526	Bristol
		Washington County Chamber of Commerce	P.O. Box 457	Chipley
		Wakulla County Chamber of Commerce	P.O.Box 598	Crawfordville
		Dixie County Chamber of Commerce	P.O. Box 547	Cross City
		Walton County Chamber of Commerce	P.O.Box 29	DeFuniak Springs
		Destin Chamber of Commerce	P.O. Box 8	Destin
		Greater Fort Walton Beach Chamber of Commerce	P.O. Box 640	Fort Walton Beach
		Greater Gulf Breeze Chamber of Commerce	P.O. Box 337	Gulf Breeze

List for E & I letters

Name	Title	Organization	Address	City
		Santa Rosa Chamber of Commerce	501 Stewart Street SW	Milton
		Monticello-Jefferson C of C	420 West Washington St	Monticello
		Bay County Chamber of Commerce	P.O. Box 1850	Panama City
		Pensacola Area Chamber of Commerce	P.O. box 550	Pensacola
		Perry-Taylor County Chamber ofCommerce	P.O. Box 550	Perry
		Port St. Joe & Gulf C of C	P.O. Box 892	Port St. Joe
		Tallahassee Chamber of Commerce	P.O. Box 1639	Tallahassee
		Niceville-Valparaiso C of C	179 John Sims Parkway	Valparaiso
		Jacksonville Convention & Visitor's Bureau	33 Hogan Street, Suite 250	Jacksonville,
		West Nassau County C of C	P.O. Box 98	Callahan
		Amelia Island Fernandina Beach C of C	P.O. Box 472	Fernandina Beach
		Flagler County C of C	P.O. 689	Flagler Beach
		Gainesville Area C of C	P.O. Box [illegible]	Gainesville
		Jacksonville Area Chamber of Commerce	P.O. Box 329	Jacksonville
		Jacksonville Beaches Area C of C	P.O. Box 50427	Jacksonville Beach
		Lake City/Columbia County C of C	P.O. Box 566	Lake City
		Clay County Chamber of Commerce	P.O. Box 1441	Orange Park
		Putnam County Chamber of Commerce	P.O. Box 550	Palatka
		St. Augustine & St. John's County C of C	P.O. Box [illegible]	St. Augustine
		Tourist Development Council	201 SE Eighth Ave	Fort Lauderdale
		Tourist Development Council	Box 866	Key West
		Tourist Development Council	555 17th Street	Miami
		Tourist Development Council	1555 Palm Beach Lakes Blvd Suite 204	West Palm Beach
		Belle Glade Chamber of Commerce	540 South Main Street	Belle Glade

List for E & I letters

Name	Title	Organization	Address	City
		Lower Keys Chamber of Commerce	P.O. box 511	Big Pine Key
		Greater Boca Raton Chamber of Commerce	P.O. Box 1390	Boca Raton
		Greater Boynton Beach C of C	639 Ocean Ave Unit 108	Boynton Beach
		Coconut Grove Chamber of Commerce	3437 Main Highway	Coconut Grove
		Coral Gables Chamber of Commerce	50 Aragon Ave	Coral Gables
		Coral Springs Chamber of Commerce	9767 West Sample road	Coral Springs
		Dania Chamber of Commerce	P.O. Box 838	Dania
		Davie Cooper City Chamber of Commerce	4185 SW 64th ave	Davie
		Deerfield Beach Chamber of Commerce	1601 East Hillsboro Blvd.	Deerfield Beach
		Greater Delray Beach Chamber of Commerce	64 Southeast Fifth Ave	Delray Beach
		Ft. Lauderdale/Broward C of C	P.O. Box 14516	Ft. Lauderdale
		Hallandale Chamber of Commerce	P.O. box 249	Hallandale
		Hialeah/Miami Springs Chamber of Commerce	59 West 5th St	Hialeah
		Greater Hollywood C of C	P.O. Box 2345	Hollywood
		Greater Homestead/Florida City C of C	650 U.S. Highway 1	Homestead
		Islamorada Chamber of Commerce	P.O. Box 915	Islamorada
		Jupiter/Tequesta Chamber of Commerce	P.O., box 817	Jupiter
		Key Biscayne Chamber of Commerce	95 West McIntyre Street	Key Biscayne
		Key Colony Beach Chamber of Commerce	P.O. Box 89	Key Colony Beach
		Florida Upper Keys Chamber of Commerce	P.O., Box 2740	Key Largo
		Greater Key West Chamber Of Commerce	402 Wall St	Key West
		Greater Lake Worth Chamber of Commerce	1702 Lake Worth Rd	Lake Worth
		Greater Lantana Chamber of Commerce	212 Iris Street	Lantana
		Greater Marathon Chamber of Commerce	3330 Overseas Highway	Marathon

List for E & I letters

Name	Title	Organization	Address		City
		Tri City Chamber of Commerce	6130 West Atlantic Blvd		Margate
		Greater Miami Chamber of Commerce	1601 Biscayne Blvd	Omni Complex, 7th Floor	Miami,
		North Dade C of C	P.O. Box 693116		Miami,
		South Dade Chamber of Commerce	900 Perrine Ave		Miami
		Latin Chamber of Commerce	P.O. Box 350824		Miami
		Miami Beach Chamber of Commerce	1920 Meridian Ave		Miami Beach
		Miami Shores Chamber of Commerce	9523 Northeast Second Ave		Miami Shores
		Northwest Dade Chamber of Commerce	45 Curtiss Parkway		Miami Springs
		North Miami Chamber of Commerce	13100 West Dixie Highway		North Miami
		North Miami Beach Chamber of Commerce	39 Northeast 167th St		North Miami Beach
		Palm Beach Chamber of Commerce	45 Coconut Row		Palm Beach
		Greater Pompano Chamber of Commerce	2200 East Atlantic Blvd		Pompano Beach
		Northern Palm Beach County C of C	3601 Broadway		Riviera Beach
		Southern Miami/Kendall Area C of C	P.O. Box 430585		South Miami
		Sunrise Chamber of Commerce	3122 North Pine Island Road		Sunrise
		Florida Gold Coast Chamber of Commerce	P.O. Box 6572		Surfside
		Greater West Palm Beach Chamber of Commerce	P.O. Box 2931		West Palm Beach
		Tourist Development Council	P.O. Box 321		Bradenton
		Tourist Development Council	P.O. Box 1398		Englewood
		Tourist Development Council	P.O. Box 2445		Ft. Myers
		Cape Coral Chamber of Commerce	2051 Cape Coral Parkway		Cape Coral
		Greater Pine Island C of C	P.O. Box 525		Matlacha
		Englewood Area Chamber of Commerce	601 South Indiana ave		Englewood
		Everglades Area Chamber of Commerce	P,O, Box E		Everglades City
		Metropolitan Ft. Myers C of C	P.O. Box CC		Fort Myers

[illegible] 12
[illegible]

List for E & I letters

[illegible]	Title	Organization	Address		City
		Fort Myers Beach Chamber of Commerce	P.O. Box 6109		Fort Myers Beach
		Marco Island Chamber of Commerce	P.O. 913		Marco Island
		Naples Area Chamber of Commerce	1700 North Tamiami Trail		Naples
		Charlotte County Chamber of Commerce	P.O. 2702 Tamiami Trail		Port Charlotte
		Sanibel-Captiva Islands Chamber of Commerce	Causeway Road		Sanibel Island
		Tourist Development Council	Newport Square #109A	2333 East Bay Drive	Clearwater
		Greater Sarasot Tourism Association	655 North Tamiami		Sarasota
		Tampa Hillsborough County Convention Bureau	100 South Ashley Drive	Suite 850	Tampa
		Manatee Chamber of Commerce	P.O. box 321		Bradenton
		Anna Maria Island Chamber of Commerce	P.O. Box 336		Bradenton Beach
		Greater Clearwater Chamber of Commerce	P.O. Box 2457		Clearwater
		Pinellas Suncoast Chamber of Commerce	St. Petersburg,Clearwater Airport	Suite 239	Clearwater
		Citrus County Suncoast Chamber of Commerce	City County Bldg		Crystal River
		Greater Dunedin Chamber of Commerce	434 Main Street		Dunedin
		Homosassa Springs Area Chamber of Commerce	P.O. Box 1098		Homosassa Springs
		Greater Hudson Area Chamber of Commerce	13740 Old Dixie Highway		Hudson
		Longboat Key Chamber of Commerce	510 Bay Isles Rd		Longboat Key
		Madeira Beach Chamber of Commerce	501 150th Ave		Madeira Beach
		West Pasco Chamber of Commerce	407 Main St		New Port Richey
		Greater Palm Harbor Area Chamber of Commerce	1000 North U.S, 19 #300	Palm State Bank Bldg.	Palm Harbor
		South Hillsborough County Chamber of Commerce	315 U.S. Highway 41 south		Ruskin
		Safety Harbor Chamber of Commerce	200 Main Street		Safety Harbor

List for E & I letters

Name	Title	Organization	Address		City
		St. Petersburg Chamber of Commerce	P.O. Box 1371		St. Petersburg
		St. Petersburg Beach Chamber of Commerce	P.O. Box 66375		St Petersburg Beach
		Sarasota County Chamber of Commerce	P.O. Box 308		Sarasota
		Siesta Key Chamber of Commerce	P.O. Box 5188		Sarasota
		Sun City Center Chamber of Commerce	P.O. Box 5203		Sun City Center
		Greater Tampa Chamber of Commerce	P.O. Box 120		Tampa
		North Tampa Chamber of Commerce	P.O. Box 8247		Tampa
		West Tampa Chamber of Commerce	3005 West Columbus Drive		Tampa
		Ybor City	1513 Eighth Ave		Tampa
		Greater Tarpon Springs Chamber of Commerce	528 East Tarpon Ave		Tarpon Springs
		Treasure Island Chamber of Commerce	P.O. Box [illegible]294		Treasure Island
		Venice Area Chamber of Commerce	257 North Tamiani Trail		Venice
		Brevard County Tourist Development Council	2235 North 'Courtney Parkway		Merritt Island
		Tourist Development Council		P.O. Box 2775	Daytona Beach
		Cocoa Beach Area Chamber of Commerce	431 Riveredge Blvd		Cocoa
		Daytona Beach Area Chamber of Commerce	P.O. Box 2775		Daytona Beach
		Daytona Beach Shores Chamber of Commerce	3616 South Atlantic Ave Suite A		Daytona Beach Shores
		St. Lucie County Chamber of Commerce	2200 Virginia Ave		Fort Pierce
		Hobe Sound Chamber of Commerce	P.O. Box 1[illegible]		Hobe Sound
		South Brevard Chamber of Commerce	1005 East Strawbridge Ave		Melbourne
		New Smyrna/Edgewater Chamber of Commerce	P.O. Box 129		New Smyrna Beach
		Ormond Beach Chamber of Commerce	P.O. Box 874		Ormond Beach
		Ormond by the Sea Chamber of Commerce	P.O. Box 2100		Ormond Beach
		Palm Bay Area Chambe of Commerce	P.O. Box 37		Palm Bay

List for E & I letters

Name	Title	Organization	Address	City
		Titusville Area Chamber of Commerce	2000 South Washington	Titusville
		Vero Beach Chamber of Commerce	P.O. [illegible]	Vero Beach
		Jensen Beach Chamber of Commerce	1910 [illegible] Commercial St	Jensen Beach

FLORIDA DEPARTMENT OF EDUCATION
CONTACT PERSON SYSTEM
DISTRICTS WITHIN CONTACT AREA
**** CONTACT AREA: 11 ENVIRONMENTAL EDUCATION ****

01 ALACHUA
MRS. DONNA STRICKLAND
SUPERVISOR OF SCIENCE

620 E. UNIVERSITY AVE.
GAINESVILLE FL 32601-5498
904/395-0586 EXT 586
651-1586

02 BAKER
DR. RONNIE O. KIRKLAND
DIRECTOR OF SECONDARY
EDUCATION
392 SOUTH BLVD. EAST
MACCLENNY FL 32063-2717
904/259-6251 EXT 110
821-5354

03 BAY
MR. CURTIS SCOTT
PROGRAM SPECIALIST

P.O. DRAWER 820
PANAMA CITY FL 32402-0820
904/872-4100 EXT 436
777-4364

04 BRADFORD
MRS. BURNEY WINKLER
DIR. OF CURRICULUM K-12

582 NORTH TEMPLE AVENUE
STARKE FL 32091-2698
904/964-6800
620-5229

05 BREVARD
MR. DAVE HOWELL
SCIENCE RESOURCE TEACHER

1274 SOUTH FLORIDA AVENUE
ROCKLEDGE FL 32955-2497
305/631-1911 EXT 510

06 BROWARD
MRS. ANGIE MATAMOROS
CURRICULUM CLUSTER SUPERVISOR
SCIENCE/HEALTH
6650 GRIFFIN ROAD
FT. LAUDERDALE FL 33314-0000
305/765-6046

07 CALHOUN
MR. JERRY EDGAR
DIRECTOR, VOCATIONAL EDUCATION

425 E. CENTRAL AVE., G-20
BLOUNTSTOWN FL 32424-0000
904/674-8144

08 CHARLOTTE
MR. ALTON L. CHEATHAM
PEACE RIVER ELEMENTARY SCHOOL

22400 HANCOCK AVENUE
CHARLOTTE HARBOR FL 33950-0000
813/625-4773

09 CITRUS
MRS. ROBERTA DILOCKER
COORD. OF MATH AND SCIENCE

1007 WEST MAIN STREET
INVERNESS FL 32650-4698
904/726-1931 EXT 260
647-1011

10 CLAY
DR. RICHARD CRUMP
SUPERVISOR, SECONDARY
CURRICULUM
900 WALNUT STREET
GREEN COVE SPRINGFL 32043-3199
904/284-6500 EXT 461
835-1508

10 CLAY
MRS. NANCY LEADERER
SUPERVISOR, ELEMENTARY
CURRICULUM
1532 KINGSLEY AVE/SUITE 110
ORANGE PARK FL 32073-0000
904/269-8130

11 COLLIER
DR. HAYDEE NAVARRO
DIRECTOR ODF INSTRUCTION

3710 ESTEY AVENUE
NAPLES FL 33942-4499
813/643-2700 EXT 621
752-1011

12 COLUMBIA
DR. JAMES YOPP
DIRECTOR OF ELEMENTARY ED.

RT. 7, BOX 541
LAKE CITY FL 32055-0000
904/752-7812

13 DADE
DR. MILDRED BERRY
SUPERVISOR, SCIENCE

1450 N.E. 2ND AVE. - ROOM 918
MIAMI FL 33132-1397
305/376-1989
432-1989

14 DESOTO
MR. WILLIAM STANKO
HEAD TEACHER, ENVIRONMENTAL
LEARNING LABORATORY
530 LA SOLONA AVENUE
ARCADIA FL 33821-4911
813/494-6611

FLORIDA DEPARTMENT OF EDUCATION
CONTACT PERSON SYSTEM
DISTRICTS WITHIN CONTACT AREA
**** CONTACT AREA: 11 ENVIRONMENTAL EDUCATION ****

15 DIXIE
MRS. PAULA M. WHITTIER
DEPUTY SUPT. FOR INSTRUCTIONAL SERVICES
P.O. BOX 3-E
CROSS CITY FL 32628-0860
904/498-5086

16 DUVAL
DR. JED KLEIN
DIRECTOR, INSTRUCTION

1701 PRUDENTIAL DRIVE
JACKSONVILLE FL 32207-8154
904/390-2129
825-2129

17 ESCAMBIA
MR. ROY L. HYATT
DIR./ENVIRONMENTAL SENSITIVITY PROJECT
P.O. BOX 636
GONZALEZ FL 32560-0636
904/968-0135

18 FLAGLER
DR. RICHARD D. CONKLING
COORDINATOR OF CURRICULUM

P.O. BOX 755
BUNNELL FL 32010-0755
904/437-3351 EXT 25
352-7100

19 FRANKLIN
MR. C. T. PONDER
SECONDARY ADMIN.

155 AVENUE E
APALACHICOLA FL 32320-2099
904/653-8835
771-4770

20 GADSDEN
MRS. MARY BAKER
CHAPTER I, PROGRAM SUPERVISOR

P.O. BOX 818
QUINCY FL 32351-0818
904/627-9651 EXT 250
791-1250

21 GILCHRIST
MR. HARRISON SCHOFIELD
DIRECTOR OF PROJECTS

P.O. BOX 67
TRENTON FL 32693-0067
904/463-2331 EXT 20

22 GLADES
MR. GEORGE STEELE
DIRECTOR OF ADMINISTRATIVE SERVICES
P.O. BOX 459
MOORE HAVEN FL 33471-0459
813/946-0811

23 GULF
MRS. BARBARA SHIRLEY-SCOTT
DIRECTOR OF INSTRUCTIONAL SERV

GULF COUNTY COURTHOUSE
PORT ST. JOE FL 32456-1698
904/229-8256
231-4906

24 HAMILTON
MS. LILLIAN SASNETT
DIRECTOR OF INSTRUCTIONAL SERVICES
P.O. BOX 1059
JASPER FL 32052-1059
904/792-1211

25 HARDEE
MR. JOHN MASTERSON
DIRECTOR OF CURRICULUM 6-12

P.O. DRAWER 1678
WAUCHULA FL 33873-1678
813/773-9058

26 HENDRY
MR. KENNETH DOOLEY
ASST. SUPT. FOR INSTRUCTION

P.O. BOX 1980
LABELLE FL 33935-1980
813/675-5266 EXT 302
735-4266

27 HERNANDO
MR. MARTIN A. YUNGMAN
DISTRICT DIRECTOR OF CURRICULUM
919 U.S. 41 NORTH
BROOKSVILLE FL 34601-0000
904/796-6761 EXT 413
630-5011

28 HIGHLANDS
MR. DEWAYNE LEMLER
COORDINATOR, SECONDARY EDUCATION
426 SCHOOL STREET
SEBRING FL 33870-6099
813/382-1121 EXT 208
742-1208

29 HILLSBOROUGH
MR. MICHAEL MULLINS
COORD. OF ENVIRONMENTAL ED.

P. O. BOX 3408
TAMPA FL 33601-3408
813/272-4821
547-4821

FLORIDA DEPARTMENT OF EDUCATION
CONTACT PERSON SYSTEM
DISTRICTS WITHIN CONTACT AREA
**** CONTACT AREA: 11 ENVIRONMENTAL EDUCATION ****

30 HOLMES
MRS. JEAN WEST
SPECIAL PROGRAMS ADMINISTRATOR

211 W. IOWA AVENUE
BONIFAY FL 32425-2103
904/547-9341
231-4054

31 INDIAN RIVER
DR. A. RONALD HUDSON
ASST. SUPT. FOR INSTRUCTION

1990 25TH ST.
VERO BEACH FL 32960-3395
305/567-7165 EXT 203
465-1203

32 JACKSON
MR. THOMAS L. MELVIN
DIRECTOR, VOCATIONAL EDUCATION

P.O. BOX 5958
MARIANNA FL 32446-5958
904/526-4510 EXT 215
774-1011

33 JEFFERSON
MRS. DOROTHY BISHOP
DIR., INSTRUCTIONAL SERVICES
& STAFF DEVELOPMENT
1490 W. WASHINGTON STREET
MONTICELLO FL 32344-1132
904/997-3562
282-4012

34 LAFAYETTE
MRS. DOLORES H. CERASO
ADMINISTRATIVE ASSISTANT FOR
PROGRAMS & PERSONNEL
P.O. BOX 58
MAYO FL 32066-0058
904/294-1351 EXT 6

35 LAKE
MRS. BEVERLY HASKINS
SUPERVISOR SECONDARY
EDUCATION
201 W. BURLEIGH BOULEVARD
TAVARES FL 32778-2496
904/343-3531 EXT 252
660-1252

36 LEE
Mr. William Hammond
Dir., Environmental Educ. &
Instruc. Dev. Serv.
Nature Center, Ortiz Avenue
Ft. Myers FL 33901-0000
813/275-3033

37 LEON
MRS. MILDRED HALL
SECONDARY SCIENCE CURR.
IMPOVEMENT TEAM
2757 WEST PENSACOLA STREET
TALLAHASSEE FL 32304-2998
904/487-7188

38 LEVY
MR. PAUL D. JOHNSON
ASSISTANT SUPT. FOR
INSTRUCTIONAL SERV.
P.O. DRAWER 129
BRONSON FL 32621-0129
904/486-2151
620-5201

39 LIBERTY
MRS. SHIRLEY BATEMAN
DIRECTOR OF INSTRUCTION

P.O. BOX 429
BRISTOL FL 32321-0429
904/643-2249

40 MADISON
MR. JAMES RAY
DIR. OF PERSONNEL AND
SECONDARY EDUCATION
P. O. BOX 449
MADISON FL 32340-0449
904/973-4081

41 MANATEE
MR. ROBERT B. KITZMILLER
SUPERVISOR OF SCIENCE

P.O. BOX 9069
BRADENTON FL 33506-9069
813/746-5171 EXT 289
536-1289

42 MARION
MR. WILEY C. KERLIN
DIRECTOR, SECONDARY EDUCATION

P.O. BOX 670
OCALA FL 32678-0670
904/732-8041 EXT 224
656-1320

43 MARTIN
DR. BARBARA ANDERSON
DIRECTOR OF ELEMENTARY
EDUCATION
500 EAST OCEAN BOULEVARD
STUART FL 34994-0000
305/287-6400 EXT 224
241-1224

43 MARTIN
MRS. BETTY COXE
DIRECTOR OF SECONDARY
EDUCATION
500 EAST OCEAN BOULEVARD
STUART FL 34994-0000
305/287-6400 EXT 253
241-1253

FLORIDA DEPARTMENT OF EDUCATION
CONTACT PERSON SYSTEM
DISTRICTS WITHIN CONTACT AREA
**** CONTACT AREA: 11 ENVIRONMENTAL EDUCATION ****

44 MONROE
MRS. BETTY COX
SPECIALIST

242 WHITE ST.-P.O. BOX 1788
KEY WEST FL 33040-1788
305/296-6523 EXT 239
420-1239

45 NASSAU
MRS. LEONA DAVIS
DIRECTOR OF SECONDARY
EDUCATION
1201 ATLANTIC AVENUE
FERNANDINA BEACH FL 32034-3499
904/261-7628

46 OKALOOSA
MR. JOE W. STANTON
SCIENCE SUPERVISOR/SECONDARY
ACCREDITATION
120 LOWERY PLACE
FORT WALTON BEACHFL 32548-5595
904/244-2161

47 OKEECHOBEE
MISS SHARON SUITS
SCIENCE EDUCATION CONTACT
INSTRUCTIONAL SERV.
100 S.W. FIFTH AVENUE
OKEECHOBEE FL 34974-0000
813/763-3157 EXT 28

48 ORANGE
MS. ARLENE BRIDGES
PROGRAM CONSULTANT. ELEMENTARY
SCIENCE
P. O. BOX 271
ORLANDO FL 32802-0271
305/422-3200 EXT 374
329-1374

49 OSCEOLA
MR. BLAINE MUSE
DIRECTOR OF MIDDLE SCHOOL &
SECONDARY EDUCATION
P.O. BOX 1948
KISSIMMEE FL 32742-1948
305/847-3928 EXT 231
352-7440

50 PALM BEACH
DR. R. CAMILLE DORMAN
ASSISTANT SUPERINTENDENT/
INSTRUCTION
P.O. BOX 24690
WEST PALM BEACH FL 33416-4690
305/684-5115
222-5115

51 PASCO
MR. STEVEN RINCK
SUPERVISOR OF SCIENCE

7227 U.S. HIGHWAY 41
LAND O'LAKES FL 34639-0000
813/996-3600 EXT 243
597-1243

52 PINELLAS
MR. THOMAS M. BAIRD
DIRECTOR, K-12 SCIENCE

205 4TH STREET, S.W.
LARGO FL 34640-0000
813/585-9951 EXT 215

53 POLK
MR. DICK MULLENAX
SCIENCE SUPERVISOR

P.O. BOX 391
BARTOW FL 33830-0391
813/534-2274
541-2274

54 PUTNAM
MRS. MEREDITH M. BARKER
DIRECTOR OF MIDDLE SCHOOL
EDUCATION SERVICES
200 S. 7TH STREET
PALATKA FL 32077-4612
904/329-0532
832-0532

55 ST JOHNS
DR. SANDRA MCDONALD
DIRECTOR, CURRICULUM AND
INSTRUCTION
40 ORANGE STREET
ST. AUGUSTINE FL 32084-0000
904/824-7201 EXT 73

56 ST LUCIE
Mr. Jack Roberts
Supervisor/Media, Career &
Consumer Education
310 Preston Court
Ft. Pierce FL 33450-0000
305/464-3051

57 SANTA ROSA
MR. NICKY WALKER
COORDINATOR/MATH & SCIENCE

603 CANAL STREET
MILTON FL 32570-6706
904/623-3663 EXT 220
691-1220

58 SARASOTA
MS. RICHARD CODISPOTI
SUPERVISOR OF SCIENCE
EDUCATION
2418 HATTON STREET
SARASOTA FL 34237-0000
813/953-5000 EXT 320
529-1320

FLORIDA DEPARTMENT OF EDUCATION
CONTACT PERSON SYSTEM
DISTRICTS WITHIN CONTACT AREA
**** CONTACT AREA: 11 ENVIRONMENTAL EDUCATION ****

59 SEMINOLE
MRS. BETTIE PALMER
CONSULTANT/COORDINATOR OF SCIENCE
1211 MELLONVILLE AVENUE
SANFORD FL 32771-2298
305/322-1252

60 SUMTER
MR. LARRY D. ROSS
INSTRUCTIONAL SUPERVISOR

202 N. FLORIDA STREET
BUSHNELL FL 33513-9401
904/793-5588 EXT 50
621-7032

61 SUWANNEE
MR. MARVIN JOHNS
DIRECTOR OF INSTRUCTION

224 WEST PARSHLEY STREET
LIVE OAK FL 32060-2396
904/362-2252 EXT 276

62 TAYLOR
MR. LAWRENCE HUGHES, JR.
INSTRUCTIONAL COORDINATOR

502 NORTH CENTER STREET
PERRY FL 32347-2757
904/584-4984

63 UNION
MR. HOWARD G. MCNEILL
ASST. SUPERINTENDENT FOR INSTRUCTION
55 S. W. 6TH STREET
LAKE BUTLER FL 32054-2599
904/496-2045 EXT 23
821-5383

64 VOLUSIA
MS. BILLIE WISNIEWSKI
SCIENCE SUPERVISOR

P.O. BOX 1910
DAYTONA BEACH FL 32015-1910
904/255-6475

65 WAKULLA
MS. SUE KEEL
COORDINATOR SPECIAL PROGRAMS

P.O. BOX 100
CRAWFORDVILLE FL 32327-0100
904/926-7131 EXT 33
277-3143

66 WALTON
Mr. James King
Director of Instruction

Park Avenue
DeFuniak Springs FL 32433-0000
904/892-2228

67 WASHINGTON
MR. PAT WILLIAMS
DIRECTOR OF INSTRUCTION

206 NORTH THIRD STREET
CHIPLEY FL 32428-1265
904/638-7222
771-4060

Marine

RECEIVED

FEB - 4 1986

BUREAU OF MARINE RESEARCH
ST. PETERSBURG, FL

Florida Department of Natural Resources
Division of Recreation and Parks
Florida Park Service

REV. 01/23/86

Park	Address	Location	Phone No.	Park Manager	County	Org. Code
Alfred B. Maclay State Gardens	3540 Thomasville Road Tallahassee, FL 32308	5.5 mi. N. on U.S. 319	904/893-4455	Charles W. Smith William J. Kellerman	Leon	7450 9020 002
Anastasia State Recreation Area	5 Anastasia Park Drive St. Augustine, FL 32085	On A1A at S.R. 3	904/471-3033	Sandra A. Cook Robert E. Joseph	St. Johns	7450 9040 003
Apalachicola River and Bay National Esturaine Sanctuary	261 Seventh Street Apalachicola, FL 32320	see address	904/653-8063 SC 231-4057	Woodard W. Miley III	Franklin	7450 5030 143
Bahia Honda State Recreation Area	Rt. 1, Box 782 Big Pine Key, FL 33043	12 mi. S. of Marathon	305/872-2353	Ronald N. Johns Thomas P. Willis	Monroe	7450 9080 005
Big Lagoon State Recreation Area	12301 Gulf Beach Hwy. Pensacola, FL 32507	10 mi. S.W.	904/492-1595	James W. Crane Keith H. Thompson	Escambia	7450 9010 128
Bill Baggs Cape Florida State Recreation Area	1200 S. Crandon Blvd. Key Biscayne, FL 33149	Off U.S. 1 over Rickenbacker Cswy.	305/361-5811	John G. Frosbutter James A. White	Dade	7450 9080 011
Blackwater River State Park	Rt. 1, Box 57-C Holt, FL 32564	Off U.S. 90, 15 mi. N.E. of Milton	904/623-2363	Robert B. Perry	Santa Rosa	7450 9010 008
Blue Spring State Park	Star Route 3 Orange City, FL 32763	2.5 mi. W. of Orange City	904/775-3663	Daniel E. Paul Nicholas D. Robins	Volusia	7450 9090 101
Bulow Creek State Park	see Tomoka	Ormond Beach, FL			Volusia	7450 9040 139
Bulow Plantation Ruins State Historic Site	P.O. Box 655 Bunnell, FL 32010	On S.R. 5, 9 mi. S.E.	904/439-2219	Ranger Robert D. Quantz	Flagler	7450 9040 009
Caladesi Island State Park	No. 1 Causeway Blvd. Dunedin, FL 33528	Extreme W end of S.R. 586, N. of Dunedin	813/443-5903	William Cutts Ronald J. Weiss	Pinellas	7450 9050 010
Cape St. George State Reserve	261 Seventh Street Apalachicola, FL 32320	see address	904/653-8063	Ranger Stephen L. Travis	Franklin	7450 5020 129
Cedar Key State Museum	P.O. Box 538 Cedar Key, FL 32625	On S.R. 24	904/543-5350		Levy	7450 9030 012

Florida State Parks

Park	Address	Location	Phone No.	Park Manager	County	Org. Code
Cayo Costa State Park	P.O. Box 1150 Boca Grande, FL 33921	Gasparilla Island (Pine Island)	813/964-0375 283-2929	Joe Crook	Lee	7450 9060 127
Charlotte Harbor State Reserve	P.O. Box 591 Bokeelia, FL 33922-0591		813/283-2424	William L. Sheftall, Jr.	Charlotte	7450 5020 133
Chekika State Recreation Area	P.O. Box 1313 Homestead, FL 33030	On S.R. 27, 11 mi. N.	305/253-0950	George L. Jones	Dade	7450 9030 090
Collier-Seminole State Park	Marco, FL 33937	On U.S. 41, 17 mi. S. of Naples	813/394-3397	Benny M. Woodham Robert J. Rahberg	Collier	7450 9060 013
Constitution Convention State Museum	200 Allen Memorial Way Port St. Joe, FL 32456	On U.S. 98	904/229-8029	Ranger Luther T. Roth	Gulf	7450 9010 014
Crystal River State Archaeological Site	3400 N. Museum Pt. Crystal River, FL 32629		904/795-3817	James P. Mielock	Citrus	7450 9050 017
Dade Battlefield State Historic Site	P.O. Box 938 Bushnell, FL 33513	Off S.R. 476, W	904/793-4781	Lewis W. Edwards	Sumter	7450 9050 018
Dead Lakes State Recreation Area	P.O. Box 939 Wewahitchka, FL 32465	1 mi. N of Wewa. E. of S.R. 70, .5 mi.	904/639-2702	Ranger Lathy Greene	Gulf	7450 9010 110
De Leon Springs State Recreation Area	P.O. Box 1338 De Leon Springs, FL 32028	Corner Ponce De Leon & Burt Parks Road	904/985-4212	Roy C. Ogles Robert Wamser	Volusia	7450 9090 145
Delnor-Wiggins Pass State Recreation Area	11100 Gulf Shore Dr., N. Naples, FL 33963	see address	813/597-6196	Edwin Higgins	Collier	7450 9060 091
Devil's Millhopper State Geological Site	4732 N.W. 53rd Avenue Gainesville, FL 32601	see address	904/377-5935	Randall Brown	Alachua	7450 9030 109
Dr. Julian G. Bruce St. George Island State Park	P.O. Box 62 Eastpoint, FL 32328	St. George Island	904/670-2111	Thomas O. Cole	Franklin	7450 9020 068
Eden State Gardens	P.O. Box 26 Point Washington, FL 32454	Off U.S. 98 on S.R. 395	904/231-4214	David E. Streeter	Walton	7450 9010 020

RECEIVED
FEB - 4 1986
BUREAU OF MARINE RESEARCH
ST. PETERSBURG, FL

Park	Address	Location	Phone No.	Park Manager	County	Org. Code
Fakahatchee Strand State Preserve	P.O. Box 548 Copeland, FL 33926	On S.R. 29, 6 mi. N. of Everglades City	813/695-4593		Collier	7450 9060 114
Falling Waters State Recreation Area	Rt. 5, Box 660 Chipley, FL 32428	On S.R. 77A, 3 mi. S.	904/638-4030	William T. Maphis, Sr.	Washington	7450 9010 021
Faver-Dykes State Park	Rt. 4, Box 213-J-1 St. Augustine, FL 32086	Off U.S. 1, 15 mi. S.	904/794-0997	Theodore W. Kersey	St. Johns	7450 9040 022
Flagler Beach State Recreation Area	3100 South A1A Flagler Beach, FL 32036	see address S.	904/439-2474	Douglas R. Carter Thomas N. Futch	Flagler	7450 9040 024
Florida Caverns State Park	2701 Caverns Road Marianna, FL 32446	On S.R. 167, 3 mi. N.	904/482-3632	Albert W. Smith, Jr. James H. Lien	Jackson	7450 9020 025
Forest Capital State Museum	204 Forest Park Drive Perry, FL 32347	On U.S. 19-98, 1 mi. S.	904/584-3227	Ranger James W. Griest	Taylor	7450 9020 026
Fort Clinch State Park	2601 Atlantic Avenue Fernandina Beach, FL 32034	On U.S. A1A, 3 mi. E.	904/261-4212	Roy G. Kemp	Nassau	7450 9040 027
Fort Cooper State Park	3100 S. Old Floral City Rd. Inverness, FL 32650	2 mi. S.E. on S.R. 39	904/726-0315	Alton C. Morrell	Citrus	7450 9050 096
Fort Gadsden State Historic Site	P.O. Box 157 Sumatra, FL 32335	On S.R. 65, 6 mi. S.W.	904/670-8988	See St. George Island	Franklin	7450 9020 028
Fort Pierce Inlet State Recreation Area	200 Atlantic Beach Blvd. Fort Pierce, FL 33449	North Beach	305/461-1570	William F. Benson Daniel T. Griffin	St. Lucie	7450 9070 106
Fort Zachary Taylor State Historic Site	P.O. Box 289 Key West, FL 33041	Southard St. on Truman Annex	305/294-2354	Jeffrey A. DiMaggio	Monroe	7450 9080 125
Fred Gannon Rocky Bayou State Recreation Area	Rt. 1, Box 597 Niceville, FL 32578	On S.R. 20, 5 mi. E.	904/897-3222	Malcolm B. McHenry	Okaloosa	7450 9010 065
Grayton Beach State Recreation Area	P.O. Box 1062 Santa Rosa Beach, FL 32459	On S.R. 30A, S. of U.S. 98	904/231-4210	James A. Murrian	Walton	7450 9010 033

Park	Address	Location	Phone No.	Park Manager	County	Org. Code
Highlands Hammock State Park	Rt. 1, Box 310 Sebring, FL 33870	On S.R. 634, 6 mi. W.	813/385-0011	Peter A. Anderson Valinda A. Nichols	Highlands	7450 9090 036
Hillsborough River State Park	15402 U.S. 301 North Thonotosassa, FL 33592		813/986-1020 SC 552-7824	Mark W. Glisson Stephen A. Yoczik	Hillsborough	7450 9050 037
Honeymoon Island State Recreation Area	No. 1 Causeway Blvd. Dunedin, FL 33528	Extreme W. end of S.R. 586, N.	813/734-4255	Jack R. Chamberlain Robert Barlow	Pinellas	7450 9050 120
Hugh Taylor Birch State Recreation ARea	3109 East Sunrise Blvd. Ft. Lauderdale, FL 33304	see address	305/564-4521	Brian L. Polk James O. Bower, Jr.	Broward	7450 9070 039
Ichetucknee Springs State Park	Rt. 2, Box 108 Fort White, FL 32038	On S.R. 47, 4 mi. N.W.	904/497-2511	Randall E. Hester Thomas Ledbetter	Columbia	7450 9030 036
John D. MacArthur Beach State Park	10900 S.R. 703 North Palm Beach, FL 33408	On Singer Island	305/627-6097	John H. Fillyaw	Palm Beach	7450 9070 140
John Gorrie State Museum	Aplachicola, FL 32320	On 6 th Street	904/653-9347	see St. George Island	Franklin	7450 9020 042
John Pennekamp Coral Reef State Park	P.O. Box 487 Key Largo, FL 33037	Ocean side of U.S. 1, 2 mi. N.	305/451-1202 SC 451-5324	Carl R. Nielsen George L. Jones	Monroe	7450 9030 015
John U. Lloyd Beach State Recreation Area	6503 North Ocean Drive Dania, FL 33004	see address	305/923-2833	Sidney J. Leve	Broward	7450 9070 107
Jonathan Dickinson State Park	16450 S.E. Federal Hwy. Hobe Sound, FL 33455	see address	05/546-2771	Donald A. Scott Greg E. Toppin	Martin	7450 9070 043
Judah P. Benjamin Confederate Memorial at Gamble Plantation State Historic Site	3708 Patten Avenue Ellenton, FL 33532	On U.S. 301	813/722-1017	Paul E. Crawford	Manatee	7450 9060 031
Kingsley Plantation State Historic Site	P.O. Box 321 Fort George, FL 32226	Off S.R. A1A, 13 mi. N.E. of Jax.	904/251-3122	see Little Talbot Island	Duval	7450 9040 044

RECEIVED
FEB - 4 1986
BUREAU OF MARINE RESEARCH

Park	Address	Location	Phone No.	Park Manager	County	Org. Code
Key Largo Coral Reef National Marine Sanctuary	P.O. Box 1083 Key Largo, FL 33037		305/451-1644	see Looe Key	Monroe	7450 5030 141
Koreshan State Historic Site	P.O. Box 7 Estero, FL 33928	On U.S. 41 at Estero	813/992-0311	Steve A. Banton Daniel C. Martin	Lee	7450 9060 045
Lake Griffin State Recreation Area	103 Highway 441/27 Fruitland Park, FL 32731	see address	904/787-7402	Keith I. Westlake	Lake	7450 9050 046
Lake Jackson Mounds State Archaeological Site	1313 Crowder Road Tallahassee, FL 32308	Off U.S. 27 N.	904/562-0042	Ranger Robert Morley	Leon	7450 9020 047
Lake Kissimmee State Park	14248 Camp Mack Road Lake Wales, FL 33853	Off S.R. 60, 15 mi. E.	813/696-1112	David C. Randall Barry A. Burch	Polk	7450 9090 087
Lake Louisa State Park	Rt. 1, Box 107-AA Clermont, FL 32711	3 mi. off S.R. 561 on Lake Nellie Rd.	904/394-2280	John F. Lynch	Lake	7450 9050 108
Lake Manatee State Recreation Area	20007 S.R. 64 Bradenton, FL 33508	see address	813/746-8042	William K. Wood	Manatee	7450 9060 088
Lake Talquin State Recreation Area	Star Route 1, Box 2222 Tallahassee, FL 32304	On S.R. 20, 20 mi. W.	904/576-8233	Hubert C. Griffin	Leon	7450 9020 093
Lignumvitae Key State Botanical Site	P.O. Box 1052 Islamorada, FL 33036	Off Coast--Long Key SRA, U.S. 1 at Layton		Patrick W. Wells	Monroe	7450 9080 097
Little Talbot Island State Park	12157 Heckscher Drive Fort George, FL 32226	see address	904/251-3231	Azell Nail Maxwell R. Forehand	Duval	7450 9040 049
Long Key State Recreation Area	P.O. Box 776 Long Key, FL 33001	On U.S. 1 at Layton	305/664-4815	John J. Roche Vickie L. Hess	Monroe	7450 9080 050
Looe Key National Marine Sanctuary	Route 1, Box 782 Big Pine Key, FL 33043		305/872-4039	Billy D. Causey	Monroe	7450 5030 144
Lower Wekiva River State Reserve	Route 1, Box 189 Sanford, FL 32771		305/322-7587	Ranger David T. Nail	Seminole	7450 5020 124

Park	Address	Location	Phone No.	Park Manager	County	Org. Code
Manatee Springs State Park	Rt. 2, Box 617 Chiefland, FL 32626	End of S.R. 320, W. off U.S. 98	904/493-4288	Charles H. Brannaka Joseph E. Smyth	Levy	7450 9030 053
Marjorie Kinnan Rawlings State Historic Site	Rt. 3, Box 92 Hawthorne, FL 32640	On S.R. 325 at Cross Creek	904/466-3672	Ranger Sally Morrison	Alachua	7450 9030 039
Mike Roess Gold Head Branch State Park	Rt. 1, Box 545 Keystone Heights, FL 32656	On S.R. 21, 6 mi. E.	904/473-4701	Paul Worthington Pamela Murfey	Clay	7450 9030 032
Myakka River State Park	13207 S.R. 72 Sarasota, FL 34241-9542	see address	813/924-1027 SC 552-7095	Robert L. Dye, II Leroy B. Wiley	Sarasota	7450 9060 055
New Smyrna Sugar Mill Ruins State Historic Site	P.O. Box 861 New Smyrna Beach, FL 32069	On S.R. 40, 1 mi. W.	904/428-2126	Ranger Sarah H. Norris	Volusia	7450 9040 058
Ochlockonee River State Park	P.O. Box 5 Sopchoppy, FL 32358	On U.S. 319, 4 mi. S.	904/962-2771	Clyde Nichols	Wakulla	7450 9020 059
O'Leno State Park	Rt. 2, Box 307 High Springs, FL 32643	On U.S. 441, 6 mi. N.	904/454-1853	Ben D. Watson	Alachua	7450 9030 060
Oleta River State Recreation Area	P.O. Box 601305 North Miami, FL 33160	.5 mi N. of FL Int. Univ. on N.E. 151 St.	305/947-6357	Paul J. Riggs	Dade	7450 9080 138
Olustee Battlefield State Historic Site	P.O. Box 2 Olustee, FL 32072	On U.S. 90, 2 mi. E.	904/752-3866	Ranger Francis J. Loughran	Baker	7450 9030 061
Oscar Scherer State Recreation Area	P.O. Box 398 Osprey, FL 33559	On U.S. 41, 2 mi. S.	813/966-3154	Darrell R. Krause Michael W. Evans	Sarasota	7450 9060 062
Pahokee State Recreation Area	P.O. Drawer 719 Pahokee, FL 33476	On U.S. 441 at Pahokee	305/924-7832	Thomas A. Price	Palm Beach	7450 9070 053
Paynes Creek State Historic Site	P.O. Box 547 Bowling Green, FL 33834	.5 mi. E. on S.R. 664-A	813/375-4717	Robert L. Henry	Hardee	7450 9090 118
Paynes Prairie State Preserve	Rt. 2, Box 41 Micanopy, FL 32667	On U.S. 441 S. of Gainesville	904/466-3397	Jack M. Gillen Tully D. Kendrick	Alachua	7450 9030 092

Park	Address	Location	Phone No.	Park Manager	County	Org. Code
Ponce De Leon Springs State Recreation Area	P.O. Box 126 Ponce de Leon, FL 32455	On S.R. 181-A, 1 mi. S.	904/836-4281	Odell L. Mize	Holmes	7450 9010 094
Prairie-Lakes State Preserve	P.O. Box 220 Kenansville, FL 32739	On S.R. 523, 8 mi. W.	305/436-1626	see Lake Kissimmee	Osceola	7450 9090 116
Ravine State Gardens	P.O. Box 1096 Palatka, FL 32077	On Twigg Street	904/328-4366	Frank J. Alogna Charles R. Dickerman	Putnam	7450 9040 035
Rock Springs Run State Reserve	Route 1, Box 189 Sanford, FL 32771		904/383-3311	Walter H. Thomson	Orange	7450 5020 150
San Felasco Hammock State Preserve	see Devil's Millhopper	Gainesville, FL			Alachua	7450 9030 119
St. Andrews State Recreation Area	4415 Thomas Drive Panama City, FL 32407	S. on S.R. 392 off U.S. 98	904/234-2522 904/234-3570	Cecil Dykes Carl O. Keen	Bay	7450 9010 067
San Marcos de Apalache State Historic Site	P.O. Box 27 St. Marks, FL 32355	Turn right at end of S.R. 363	904/925-6216	See Ochlockonee River	Wakulla	7450 9020 071
Sebastian Inlet State Recreation Area	9700 South A1A Melbourne Beach, FL 32951	see address	305/727-1752	Perry J. Smith David Jowers	Brevard	7450 9070 072
Stephen Foster State Folk Culture Center	P.O. Drawer G White Springs, FL 32096	On U.S. 41 N.	904/397-2733	Richard W. Miller Jimmy R. Richards	Hamilton	7450 9030 137
Suwannee River State Park	Rt. 8, Box 297 Live Oak, FL 32060	On U.S. 90, 13 mi. W.	904/362-2746	Terry L. Pitts	Suwannee	7450 9030 073
T. H. Stone Memorial St. Joseph Peninsula State Park	Star Route 1, Box 200 Port St. Joe, FL 32456	On S.R. 30 off U.S. 98	904/227-1327	James C. Mock Johnny Mize	Gulf	7450 9010 069
Tenoroc State Reserve	3829 Tenoroc Mine Road Lakeland, FL 33805		813/665-6270	Peter D. Woodward	Polk	7450 5020 148

Park	Address	Location	Phone No.	Park Manager	County	Org. Code
The Barnacle State Historic Site	see Bill Baggs Cape Florida	3485 Main Highway, Coconut Grove, FL			Dade	7450 9080 105
Three Rivers State Recreation Area	Rt. 1, Box 15-A Sneads, FL 32460	On S.R. 271, 2 mi. N.	904/593-6565	Russell A. Williams	Jackson	7450 9020 075
Tomoka State Park	2099 North Beach Street Ormond Beach, FL 32074	see address	904/677-3931	George H. Carson Michael S. Heller	Volusia	7450 9040 076
Torreya State Park	Rt. 2, Box 70 Bristol, FL 32321	On S.R. 12, 13 mi. N.E.	904/643-2674	Willie F. Williams	Liberty	7450 9020 077
Waccasassa Bay State Preserve	P.O. Box 187 Cedar Key, FL 32625	West on S.R. 326	904/543-5567	Reginald C. Norman	Levy	7450 9030 100
Washington Oaks State Gardens	Rt. 1, Box 128-A St. Augustine, FL 32086	On A1A, 2 mi. S. of Marineland	904/445-3161	Walter W. Young John R. Ganson	Flagler	7450 9040 079
Weedon Island State Preserve	1500 Weedon Island Drive St. Petersburg, FL 33702	see address	813/577-0651	Robert H. Baker	Pinellas	7450 9050 111
Wekiwa Springs State Park	1800 Wekiwa Circle Apopka, FL 32703	Off S.R. 436, 3 mi. N.E.	305/889-3140	Paul E. Perras Thomas C. Linley	Orange	7450 9090 030
William Beardall Tosohatchee State Reserve	3365 Taylor Creek Road		305/568-5893	Charles C. Matthews	Orange	7450 5020 132
Ybor City State Museum	see Weedon Island	1818 9th Ave., Tampa			Hillsborough	7450 9050 123
Yulee Sugar Mill Ruins State Historic Site	see Crystal River	On S.R. 490, W. of U.S. 19 in Homosassa			Citrus	7450 9050 082

Park	Address	Location	Phone No.	District Manager	County	Org. Code
District I Office	4415 Thomas Drive Panama City, FL 32407	St. Andrews State Recreation Area	904/234-3751 SC 221-3420	Glavis C. Tiller, Jr.	Bay	7450 9010 991
District II Office	3540 Thomasville Road Tallahassee, FL 32308	Alfred B. Maclay State Gardens	904/488-3648 SC 278-3648	Johnny Johnston	Leon	7450 9020 992
District III Office	4801 S.E. 17th Street Gainesville, FL 32601		904/373-3665 SC 620 5158	William L. Perry	Alachua	7450 9030 993
District IV Office	2099 North Beach Street Ormond Beach, FL 32074	Tomoka State Park	904/677-1122 SC 352-7614	Gilbert N. Becker	Volusia	7450 9040 994
District V Office	Rt. 1, Box 107-AA Clermont, FL 32711	Lake Louisa State Park	904/394-2280 SC 352-7110	Torrey Johnson	Lake	7450 9050 995
District VI Office	P.O. Box 398 Osprey, FL 33559	Oscar Scherer State Recreation Area	813/966-3594 SC 552-7740	John A. Baust	Sarasota	7450 9060 996
District VII Office	P.O. Box 8 Hobe Sound, FL 33455	North Beach Road, Jupiter Island	305/744-7603 SC 451-5321	Richard A. Domroski	Martin	7450 9070 997
District VIII Office	P.O. Box 2660 Key Largo, FL 33037	John Pennekamp Coral Reef State Park	305/451-3005 305/451-3027 SC 451-5325	Michael K. Murphy	Monroe	7450 9080 998
District IX Office	1800 Wakiwa Circle Apopka, FL 32712	Wekiwa Springs State Park	305/889-8246 SC 352-7065	Arnold P. Kuenzler	Orange	7450 9090 999
Historic and Evironmental Land Management	3900 Commonwealth Blvd. Tallahassee, FL 32303		904/488-6242 SC 278-6242	Russell K. Danser	Leon	7450 5020 951